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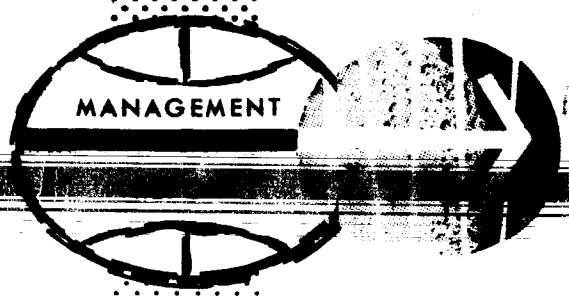
COMPATIBILITY OF COORDINATE INDEXING OF BOOKS WITH TECHNICAL REPORT LITERATURE FOR THE NASA MSC MECHANIZED RETRIEVAL SYSTEM

By Martin P. McDonough and Geoffrey J. Roth



MANNED SPACECRAFT CENTER

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The intention of this study was to provide the Technical Library of the Manned Spacecraft Center (MSC) with reference data for projects under consideration for the future. Included was the development of computerized methods of information retrieval and selective dissemination of information (SDI) in order to increase service to the library patrons.

The work undertaken was the in-depth indexing of a test collection of technical books and monographs at the chapter level using a coordinate approach and a standard-subject authority list. The descriptors assigned were transformed into machine-readable form through the use of a standardized indexing form. The resulting punched cards were edited onto magnetic tape using a UNIVAC 1108 computer and subsequently used to retrieve document references after test questions were manufactured and key punched.

As a result of the study some of the problems which might be expected to occur in the indexing operations were pin-pointed, also some initial time-cost data were generated. The efficiency of the indexing and retrieval operations was studied to provide some measurement of the compatibility of indexing books with technical reports and of the feasibility of using the coordinate approach.

NASA INFORMATION SYSTEM

To increase the effectiveness of dissemination of information to NASA and contractor personnel, NASA maintains a national information net, as well as facilities at local NASA installations. Figure 1 shows

FOREWORD

This study was undertaken with the aid of an assistantship in the Information Retrieval and Dissemination Program of the Aerospace Analysis and Writing Program in the summer of 1966 at the National Aeronautics and Space Administration Manned Spacecraft Center, Houston, Texas. This appointment provided an opportunity for college graduates to broaden their experience and training in aerospace-related activities and, consequently, to enhance their academic work. The assistantship was assigned on the basis of academic background and special interests. The job involved in-depth application of basic knowledge of an engineering or scientific field to the problems of selective dissemination of information with special reference to the NASA system of scientific classification.

CONTENTS

FIGURES

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To increase the effectiveness of dissemination of information to NASA and contractor personnel, NASA maintains a national information net, as well as facilities at local NASA installations. Figure 1 shows

the flow of information to the user at MSC. The main source of publication is NASA. The NASA publications tend to dominate, especially in the report literature with reports generated from contracted research. The non-NASA publications consist mainly of technical books and journals. For the purposes of this study, the materials (books and reports) came from both sources.

These sources converge into the MSC information system which includes the library facilities as well as machine searches and the Selective Dissemination of Information (SDI) Program in which users are automatically notified of items of interest to them. The point to be made is that the user is at the bottom of the information structure. Interposed between the user and the information being sought are two primary access tools: (1) a machine search, either on demand or SDI, and (2) a manual search.

The manual catalog has been generated primarily as a result of anticipated book usage, but this last link is redundant. The redundancy could be eliminated by making provision for entering books into the machine retrieval system. The computer could easily generate catalog cards if desirable or convenient.

The background against which the study was undertaken has been indicated. By eliminating the redundancy in the system a more useful collection is anticipated. Admittedly, this looks toward the future, but the future must be planned for in the present.

DEFINITION OF TERMS INVOLVED

To assure effective and meaningful communication, the exact meanings or levels of meanings of the words used must be known. Such a lofty ideal is practically unattainable. For the sake of clarity, the following words are defined as they will be used throughout this report.

Indexing

Vickery has pointed out (ref. 1) that indexing a document may be considered as a series of transformations in which the information in the document is extracted, compressed, rearranged, and transformed, with nothing being created, but just changed in form.

Indexing may also be viewed from a functional aspect rather than from the operational one described above. In that case, indexes or condensed surrogate representations of documents have a dual purpose

(ref. 2): (1) to serve a search-tool function and (2) to serve a content-revealing function. Traditional subject indexing appears quite limited in its value both as a search tool and as a content-revealer because it more frequently operates on a restricted whole-document level with a limited number of headings. Thus, traditional approaches are usually limited to a few rather broad entries rather than to many more specific entries.

Coordinate Index

Descriptions of the various systems of indexing devices in use today often present a set of conflicting claims and confusing terminology. Foremost among these confusing terms is the coordinate index, referred to in various literature as correlative indexing, multiple aspect indexing, concept coordination, or "enriched" indexing.

Regardless of what this type of indexing may be called, it is the actual operational aspects of the system that set it apart. A coordinate index is different from other indexing systems in that it is manipulatable. In traditional alphabetical subject headings, each heading is a fixed and complete entity describing the contents of whatever is indexed. Any item in such a system may be adequately represented by one or by several headings without any further operations being performed upon it.

In a coordinate indexing system a descriptor or subject heading can be combined with another descriptor to represent the subject of a document. Thus, a search using a coordinate index depends upon logical Boolean operations performed on classes defined by the headings in the system. The word, manipulative, was applied by Charles Bernier (ref. 3) to characterize this approach.

The term coordinate index as used in this study refers to a condensed surrogate representation of a whole document or of part of that document. This representation serves as a search tool and as a content-revealer by the joint use of two or more terms (called descriptors, keywords, Uniterms, and so forth, in various systems). Retrieval is performed on a matching basis by the Boolean operations of intersection, union, and negation through the manipulation of classes of index terms.

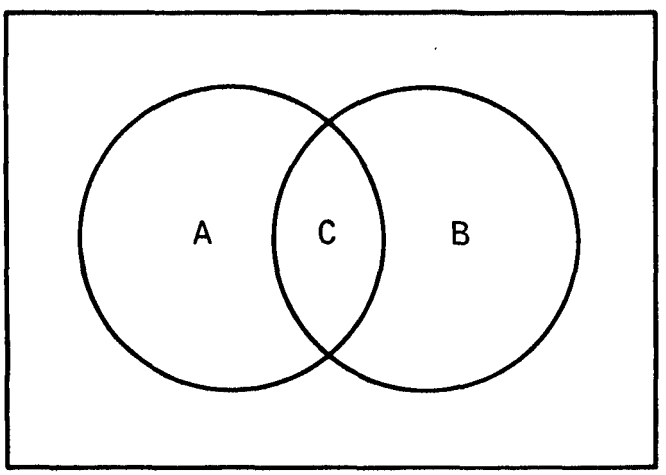
Information System

The total organization of equipment, items, processes, and personnel necessary to optimize output of information in order to meet the needs of the user is referred to as an information system.

Compatibility

Compatibility is defined as the ability of one information system to accept the original indexing and/or abstracting of another information system for any given subject coverage common to both systems (ref. 4).

A model of the interrelation of two information systems can be found in a Venn diagram descriptive of the logical equation defined above. The conditions of the equation are that any given subject coverage be common to both systems. If that is the case, then the logical equation $C = A \cdot B$ holds true, where both A and B are contents of separate information systems and C is the subject coverage common to both. The compatibility of two informations systems is shown in the following Venn diagram:



It naturally follows that the greater the overlapping of two systems, the more compatible the systems. Two conditions are necessary for a larger overlap: (1) a mutual acceptance of original indexing and/or abstracting, and (2) expansion of common subject coverage.

Authority File

The authority file refers to a structured or unstructured collection of concept descriptors, by means of which information input is classified, controlled, and searched. The subject authority list used in this study and in the NASA Information System net is an unstructured file. A sample of this subject authority list is shown in figure 2.

THE INDEXING PROCESS

The indexing process is a complicated, decision-making process in which the significant and important ideas are reduced into concise surrogates of the original item indexed. This surrogate can then perform its proper functions in the information framework. A model showing the usage of an index in the information framework is shown in figure 3.

The input into the information framework is printed data of some form. These are received and analyzed to determine which index terms are to be assigned to the document. When this is done, an index code pattern is determined, and the document is placed in the file.

A user interacts with the index and the file and employs certain logical processes to make use of any document. The user obtains new ideas or employs ideas from the document to generate a new document, and the closed loop starts over again.

As subjective judgment is so deeply entrenched in the indexing process, evaluation of indexing is extremely difficult, if not impossible. Because the intellectual operations of the indexer must be taken into consideration and no suitable method has been found for doing this, criteria for measuring indexing quality have not been evolved. What has been done, however, is to identify some of the parameters which define the range of variables influencing the indexing process. Some of the variables influencing the indexing process are:

(1) The characteristics of the indexer

(2) The amount of variance or ambiguity within the system

(3) The relative subject importance of the material indexed

(4) The method of indexing

(5) The indexer training

(6) The depth of indexing

(7) The indexing environment

(8) The problems arising from file organization

Few cataloging or indexing techniques avoid the possibility that a document or file item may be indexed differently by different indexers--in fact, there is often a strong possibility that an indexer would classify a document differently on different days. To compound matters, the problem seems to increase with the number of indexers. Differences in background and training result in different appraisals of the subject material and, consequently, in different indexing approaches. As the indexer becomes more familiar with the special terminology and novel aspects of the material, the indexing habits change. In effect, the indexer, employing the subjective indexing process, has arrived at an estimate of the importance of the subject matter. As long as the indexer's appraisal agrees with the system design, nothing is lost; but when a wrong or inaccurate estimate of the importance of the subject matter is made, chaos reigns supreme.

Several steps are taken to control the degree to which the indexer makes this decision. First, provision is made for adequate supervision and review of the indexer's work. Second, an authority list of subject headings is used to reduce the variance or ambiguity within the indexing system by providing written descriptions and clarifications of the various subject headings or terms used, or a listing of those terms which are acceptable. It must be emphasized, however, that a thesaurus or word authority list can only present qualitatively acceptable terms and cannot indicate the applicability of any term to any specific document. It is of value in that it helps the indexer make subjective value judgments of terms, but the final decision is made by the indexer.

Another variable in the indexing process is the method of indexing used in the system. For example, traditional subject indexing on catalog cards employs a different approach than does coordinate indexing. Each particular system has its own peculiarities (for example, assignment of links and roles) which influence the indexing approach.

Indexer training is another factor which can affect the entire indexing process. If the indexer is not familiar with the subject matter, more time is necessary to understand the basic concepts of appraising the significant and important ideas within a document. Also, there is a certain "feel" that an indexer must develop intuitively for the process as a whole in order to be psychologically oriented to the particular task.

One very important parameter influencing the indexing process is the depth of indexing undertaken. As a general rule, the deeper the degree of indexing, the more time necessary to index any given document. Of course, as the number of descriptors assigned per document increases, so will the time and the cost.

In addition, if attempts are made to assign additional indicators, for example, to show what chemical was used as a reagent or what product was formed, then time and costs at the input stage also rise accordingly.

In this study indexing was undertaken at the chapter level to take advantage of the organization of the author and publisher at one of the most significant levels in a book.

The indexing environment also influences the indexing process. If the indexer is subject to many annoying noises and interferences, his output can be expected to diminish. Indexing requires concentration in an appropriate atmosphere.

Problems arising from file organization influence the indexing process. First, there is indexing discontinuity caused by personnel changes. For large files, adequate documentation of the rules and procedures must be provided if discontinuity is to be avoided. Second, loss of material from the file can influence the indexing process. If at all possible, the integrity of the file should be maintained. Third, loss of familiarity with the file contents causes a shift in the terms assigned. Fourth, loss of familiarity of the subject matter also creates differences in indexing. Fifth, items purged or weeded from the file can no longer be allowed to influence choice of terms. Sixth, modification of original file structures is usually both intellectually and technically difficult. The reviser must decide how to change the file structure to correct for initial oversights, how to allow for changes in subject emphasis, and how to allow for future requirements that cannot be known beforehand.

All these problems can be summarized by the fact that any indexing system must be geared to the needs of the users, and this should be paramount in the design and selection of the system. With this thought in mind, the following criteria must be considered for the selection of an indexing system (ref. 5).

(1) Type of ultimate user (users vary in needs, habits, and approaches)

(2) Type of immediate user (librarian or customer)

(3) Characteristics of the file collection (current and expected size, rate of growth, variety and complexity of subject content, and format of file material)

(4) Availability of other existing indexes for the same type of file material

(5) Complexity and required accuracy of searches to be conducted (current awareness, comprehensive retrospective searches)

(6) Number of searches expected and their required response time

(7) Current user and librarian attitudes toward the existing indexing system and form of display

(8) Resources available for developing the system, converting the backlog of material to the new system or new method of display, and maintaining the routine operation

OBJECTIVES OF THE STUDY

The following objectives were established to meet the aim of this study.

(1) Studying the feasibility of coordinate indexing of technical books and monographs

(2) Investigating the compatibility of book and monograph indexing with report indexing

(3) Undertaking an initial investigation of the possible ways in which indexing of books will interface with the NASA system for disseminating information and the MSC Information System in particular

(4) Obtaining initial cost-time data for consideration of possible undertakings in this area in the future

CONSTRUCTION OF TEST SITUATION

Sampling Technique

The input of books into the NASA Technical Library was monitored for a period of 5 weeks to simulate a valid indexing situation. It was felt that by using this method, a representative sample would be received. This procedure allowed the indexer to use the cataloging done by the book cataloger as a basis for comparison.

However, processing of the books by the cataloger proved to be entirely too slow, so that in some cases accession numbers were arbitrarily assigned to new books. Furthermore, a random selection of books from the shelves of the Technical Library was used to round out the subject collection.

The 34 subject categories of STAR (Scientific and Technical Aerospace Reports, a NASA-published current index to report literature) were chosen as a convenient tabulating medium, as an intermediate grouping class to facilitate the indexing process, and as a test of the degree of compatibility between book and report categories.

The tentative hypothesis was that no real difficulty would be encountered in making books fit into report categories. In actual operation these categories were found to be quite sufficient, and the books were easily categorized. For a listing of these categories, with scope notes describing the contents of each, see appendix A.

The books chosen for the test collection were not picked in a haphazard manner. They were evaluated in terms of the following criteria:

(1) The book must be of a scientific or technical nature.

(2) The book must fit readily into one or more of the 34 subject categories of STAR.

(3) The book must not be a type that will be indexed in NASA system indexes.

(4) Handbook and textbook materials may be included depending on the format, subject, and range of material included in them.

(5) Collections of papers will be included if the collection is sufficiently well defined in one or two subject areas.

(6) Volumes in a continuing series will not be excluded, as long as the whole volume is devoted to a well-defined subject—either singularly or as a portion of the series.

The exclusion of textbook materials was not entirely successful, nor highly desirable. The original selection criteria, set up as the indexing progressed, called for the exclusion of all text material. However, more experience with indexing modified this original criteria so that texts which used the "shotgun technique" of saying little about many things were excluded. Far too many descriptors were being assigned, and far too many false drops would occur in the retrieval operation.

Test Population

It was originally proposed to index, if possible, several thousand books. However, the time spent in indexing, transcribing contents onto transmittal sheets, keypunching sheets, transferring the cards to magnetic tape, manufacturing questions to test the efficiency of the

indexing procedure, and writing the report of all these activities necessitated a reduction from thousands to hundreds. An effort was made to give equal representation to each STAR category with an average of eight books per category.

Indexing Procedure

The normal indexing procedure was followed in this study. The indexer first familiarized himself with the material; recognized, identified, and evaluated the key points and salient features of the book; and then described the book and its contents. The procedure as a whole is shown in figure 4.

After having evaluated a given book for inclusion in the test sample in the light of the selection criteria, the first step of the indexer was reviewing the contents of the book. This process, essentially one of familiarization, generally included reading of the introduction, preface, or book jacket; scanning the table of contents to see what is covered in the book; scanning one chapter or so to arrive at some idea of the author's style, organization, and format; scanning the book index to get some idea of the terms used in the book; and then briefly seeing how well the table of contents describes sections of chapters since most of the terms eventually come from the table of contents. After completing this process, the key points presented by the author were identified and evaluated.

Initially the indexing was done on 5- by 7-inch index cards, and the editing was done later in batches. It was found, however, to be too time consuming to do editing at a later time, since it necessitated looking over the book once more to refresh the indexer's memory of terms assigned. Accordingly, all editing of terms and other steps necessary for describing the book as it would appear in the automated system were standardized in the form of a Document Processing Sheet. The use of this form (essentially a transmittal sheet for the keypunch operators) enabled the indexer to assign all necessary information from the book only once, and possessed the added advantage of interfacing quite easily with the report indexing as it is an adaptation of the form used there.

A sample Document Processing Sheet is shown in figures 5 and 6. The Document Processing Sheet consists of two pages, the first being devoted to description of the book and the second being reserved for subject terms or descriptors assigned to the books. All of the little squares on the paper may seem rather ridiculous. In practice, however, it is very useful because the indexer is allowed to retain some degree of control over the format of the documents indexed; and keypunching errors are reduced by making the format of each card extremely clear.

Figures 7 and 8 show the relation between the Document Processing Sheets and standard punched cards. The numbered squares on the processing sheet correspond to the number of positions available on the punched cards. The data fields and what they were used for have been marked, the major fields (those used the most) with continuous lines and the minor fields with broken lines.

A comparison of figure 5 with figure 7 shows that each horizontal line on the Document Processing Sheet (identified by the card indentification column) corresponds to one punched card, with the exception that the Source Supplementary and Contract Number lines are not used in describing books.

A comparison of figure 6 with figure 8 shows also that each line of the second page is equivalent to one punched card. In this case, however, because of the fixed data fields, three descriptor areas are given on each card with 23 spaces available for spelling each descriptor. At the end of the data field the spelling must stop even if it is in the middle of a word. This has not presented a problem because use has shown that in the majority of cases 23 spaces is enough to recognize most terms.

The first step in filling out a Document Processing Sheet is to write in the accession number of the book. Since this is the book identification number for the computer, it is most important that it be copied correctly. Then, the descriptive cataloging is done by writing in the document title, the name of the author (personal or corporate), the Library of Congress classification number in the report number space, the imprint (publisher, place, and date), and any necessary notes.

After the book has been adequately described on page 1 of the processing sheets, page 2 is completed with the descriptors assigned to the book. At this time, the terms are edited against the subject authority list; and a rather complex decision-making process is carried out, as indicated by the successive diamond-shaped decision blocks on the flow chart in figure 4.

There are five possible combinations of events that can happen during the editing process. First, the simplest event is when a term assigned matches exactly with the authority list term. In that event, the term is entered directly on page 2 of the processing sheet. Second, there is the possibility of a generic match, that is, the term assigned from the book matches except for tense, spelling, and so forth. Here the desirable term is found in the authority list and is entered on the document processing sheet. Next come two cases of coordinate matching. In coordinate match 1, the term from the book may be divided

into a term from the authority list and a term already listed. Coordinate match 2, however, uses two separate terms from the authority list to describe one term from the book. In either of these last two events, the term or terms are then entered on the processing sheet. The last possibility is that the term will not match any of the above conditions. In that case, a review of the importance of the term is necessary to see if it should be dropped or retained. If retained, it is transcribed onto the processing sheet, keypunched, and stored on magnetic tape.

Indexing Procedure Control

Indexing was done at a chapter level in this study. The decision was made that the chapter level would be used in order to employ the existing logical structure and format of the books, as well as the organization, on a meaningful level. Moreover, the structuring of the indexing remains that of the author. Each chapter in each book was reviewed for the main ideas.

An indexer's log of decisions made during the execution of the study was kept to assure compatibility with existing indexing procedures. The log was also kept to insure accuracy in reporting events which influenced the indexing output.

To control consistency of indexing—never an easy task and often impossible—several indexing checklists were used. Two checklists are included, the first from DDC (Defense Documentation Center, the central facility for scientific and technical documentation of the Department of Defense) (fig. 9) and the second from the Engineers Joint Council, a federation of 21 chemical, electrical, mining, civil, and mechanical engineering societies (fig. 10).

Reference Time

Any time needed for reference or look-up work was included in the total indexing time per book. This time was included in the total because it was required for familiarization with the subject and recognition of important points. Reference time was found to be a function of (1) the indexer's acquaintance with the subject matter (reference time was less in chemistry with which the indexer was familiar); (2) the level of writing in the book (a more abstruse style and a higher plane of scientific language demand more time); and (3) the degree of organization of the book.

RESULTS OF THE STUDY

Time-Cost Data

Throughout the study, various statistics were recorded in order to evaluate the indexing procedure. These statistics included (1) output per indexing period, (2) total and average number of descriptors assigned per book per indexing period, and (3) total time required for each indexing period and average indexing time per book. An indirect estimate of the cost can be made by examining the estimates of the time necessary for indexing.

Indexing output is a function of many variables, some of which have already been mentioned. Figures 11, 12, and 13 show some of the variation and some of the reasons for this variation. Figure 11 shows the output in books per indexing period. That the output is highly variable is readily evident, but the reasons why it is variable are not so evident. In order to fully understand the variables to which output is related, figures 12 and 13 and some additional information are necessary.

First, there is the extremely low dip for the 6th indexing day which must be explained. There are two reasons why this dip exists: (1) loss of familiarity with the file contents because no indexing was done for 1 week and (2) the nature of the material to be indexed. In this last instance, the material was extremely difficult—it consisted entirely of math books, one of which was Einstein's Unified Field Theory. This in itself is not so bad, but coupled with the high output for the prior indexing period, one must conclude that the subject background of the indexer plays an extremely important part in the indexing process. In this case the subject background of the indexer was chemistry, and the high output for the 5th day contained large amounts of books about chemistry. Particular attention must be paid an indexer's background and experience if he is to operate at maximum efficiency. Also, this study shows that once an indexer has been selected he should continue to index for prolonged periods of time since significant amounts of downtime occur with time absent from indexing.

The graph in figure 11 is divided into two highly significant parts with the division occurring on the 6th indexing day. Up to that time the system was under development, and the decisions regarding the indexing changes were being made as they occurred. A noticeable improvement can be seen in the system once these decisions had been finalized (starting with the 6th indexing day). The improvement is evident not only in the output, but also in the number of descriptors assigned and in the indexing time necessary. The number of descriptors assigned and the necessary indexing time determine the optimum operation of the indexing phase of any retrieval operation.

Figure 12 shows the average number of descriptors assigned per indexing period. The graph in figure 12 is inversely related to the graph in figure 11. As the output increases, the number of descriptors assigned decreases; and as the number of descriptors assigned increases, the output decreases.

Similarly, there is a relation between the graph in figure 12 and the graph in figure 13. A comparison of these two graphs shows them to be quite similar. The conclusion is that the number of descriptors assigned is a function of the time spent in the indexing effort. As the indexing time increases, so does the number of descriptors assigned. Using this fact alone, the parameters governing the design of a given system come into play. If, for example, 60 descriptors per book are desired, an indexer must be prepared to pay in terms of increased indexing time and of decreased output.

Figures 11 and 13 are also related in that they display the inverse relationship as indicated between figures 11 and 12, but this is to be expected. A greater distance between corresponding points on the two curves is indicative of an inefficient system operation. As the two lines converge, a more efficient system operation is indicated. These graphs show that in the 1st week or so (again the dividing line is the 6th indexing day) the system was not operating at all efficiently—the output was high, but the indexing time and the number of descriptors assigned were low. This was the "debugging" or developmental period of the system.

As the indexing progressed and certain changes were made, the system began to operate much more efficiently, as the graphs indicate. In any up-scaling of the indexing to a full-scale process, the same thing can be expected to happen in the initial period of operation and development of the system. This study does not provide enough data to give any predictions as to the length of time necessary for developing the system. In actual operation, however, it can be identified through efficiency of the retrieval operations, and shakedown time should not be as long if the indexing parameters are predetermined before the system goes into operation.

Final figures from the project give the following results:

(1) Average number of books indexed per day 5.71

(2) Average number descriptors per book 25.86

(3) Average indexing time per book (minutes) 39.01

To give some meaning to these figures, a comparison with traditional book cataloging can be undertaken. Traditional book cataloging

and indexing are different even though they have the same ultimate goal—retrieval of items of information. In general, they deal with different size units of knowledge and to some extent with different types of information. A book catalog generally leads a user to more broad treatments of a subject, while an index leads him to more specialized items. Hierarchical relationships are displayed on catalog cards, while in indexes these relationships are not shown directly, though they may be created by logical manipulation of the index terms.

Furthermore, the process of cataloging a book differs significantly from indexing. A book cataloger seeks to create terms or subject headings that individually characterize the whole book or a large portion of it. The mental makeup of the cataloger is essentially synthetic, and the process is one of synthesis.

The indexer, on the other hand, seeks to select terms that reflect the aspects of the subject treated in terms of interest or significance to a particular mission. His mental makeup is essentially analytic, and the process is one of analysis. The fundamental difference that exists between the thinking of the cataloger and of the indexer suggests that for maximum productivity and highest quality of product different specialists may be needed.

Having differentiated between catalogers and indexers, some comparison should be given to their respective outputs. An average cataloger, doing original cataloging, should be able to catalog 9 to 12 books per day. If catalog cards supplied by the Library of Congress Card Division are used and some original cataloging is done, the output should be in the neighborhood of 24 books per day.

In this study the indexing output ranged from 3 to 12 books per day, with an average of 5.71 books per day. Considering the differences in the two processes, the results are comparable. Comparisons may also be made concerning the effectiveness of the resultant products of these two different efforts.

In book cataloging for the NASA MSC Technical Library, a typical book averages between four and five access points, that is, an author card, a title card, and two or three subject cards. The same typical book, subjected to coordinate indexing, has approximately 29 access points—author, STAR subject category, LC (Library of Congress) classification, and an average of 25.86 descriptors per book in place of the normal subject cards of a manual catalog.

On the basis of the information available, an idea of the costs involved may be seen. In order for the output of a book-indexing operation (8 books per day optimum) to equal that of a book cataloging operation (24 books per day) a 200-percent increase in personnel would

be necessary. To offset this increase in costs, the larger number of access points per book would increase the usefulness by approximately 600 percent. The cost is increased, but the comparatively greater increase in anticipated usefulness because of the greater number of access points should also be a factor in any cost decision.

Cataloging and indexing, however, are only parts of information storage and retrieval systems. The final evaluation of any such systems must also include measures of comparative retrieval effectiveness, as well as measures of feasibility of particular approaches, and compatibility with the entire operation. These will be considered in the following sections.

Feasibility of Coordinate Indexing

To evaluate the first two objectives of this study, the retrieval effectiveness of the system had to be evaluated. This was done in the following manner. First, questions were manufactured from books within the test collection. These questions, listed on a transmittal sheet, were then keypunched and fed into a UNIVAC 1108 computer along with a logical equation for determining the search strategy. The computer performed test searches to see if known source references could be retrieved. A listing of the questions asked, the logical equations used, and the answers retrieved can be found in appendix B. The first five pages of appendix B bear the heading Problem Validation. This is simply a subroutine of the program in which problems are either accepted or rejected for searching on the basis of valid logic equations and descriptor assignment.

To standardize the input of the questions, the transmittal sheet shown in figure 14 was used. This is the same sheet used in the MSC SDI program. The limit codes in columns 7 and 8 are similar to the card identification code used on the input into the computer tape, that is, it is for machine use in the retrieval program.

From this transmittal sheet, a set of punched cards were generated (fig. 15) which were then fed into the computer. In this study the cards included a problem identification card (*1, at the top left of fig. 15), a question card (*2, which stated the search question), a series of search terms (identified by limit code 40 and alphabetic order), and a logical equation whose terms corresponded to the letter of the alphabet of the search terms. The problem identification number was keypunched in the first two positions and was used for machine sorting and collation according to the dictates of the program.

The logical equation referred to in the above paragraphs is a search strategy based on Boolean algebriac operations. This essential

feature of a coordinate index (manipulability) permits varying degrees of structure in the course of searches. Logical equations may be categorized as follows:

(1) Loose—high output and irrelevant material expected

(2) Moderately loose—some irrelevant material expected

(3) Moderately tight—some irrelevant material expected, but less than in category (2)

(4) Tight—no irrelevant material expected

A survey of the logical equations used (appendix B) reveals that each of the above categories of searches were tried. Results varied, but largely all levels were successful with categories (1) and (4) being somewhat more difficult owing to the size of the test collection.

In actual operation the request must be gaged carefully to decide which type of equation should be used. Experience with the effect of both search limits and restrictions is necessary. While using the system, the operator should vary the parameters of the search questions in order to gain familiarity with the system and with what it can and cannot accomplish.

Results of Feasibility Study

Varying results were obtained with this system. Initially the system was plagued with problems in the computer program. On the first run, the printout contained garbled information after the first several listings. Whenever the number of descriptors was 30, the remainder of the program was either useless or the first set of descriptors was duplicated. This difficulty was remedied, only to have another problem arise in the use of error flags. This problem was such that if any search problem was rejected, no problem after it was accepted. For this reason the first several runs on the computer produced no more than three answers, each problem after that being rejected.

Once these difficulties were remedied, the system operated at 72.2 percent efficiency. In view of the fact that the present SDI system is only achieving approximately 60-percent retrieval efficiency, this idea seems rather feasible.

However, there are several problem areas upon which it is necessary to focus attention before any conclusion is reached. First, there is the

area of computer program inadequacies. The inadequacies fall into the following categories:

(1) Inability to search under author surnames except as given in author authority list and used as subject descriptors

(2) Inability to search by classes of LC numbers (The system does not operate within a restricted range of LC numbers, but operates on exact matches of subject matches.)

(3) Thirty descriptors available for each book (The alternate approach of using a B designation on the accession number for any additional descriptors was tried and found unsatisfactory because no coordination is permitted between accession numbers.)

(4) Inability to perform title searches (No provision is now available.)

(5) Inability to search by STAR subject category (A full investigation of the needs of the system needs to be made regarding this type of search.)

These inadequacies need further investigation to assure that a large degree of compatibility will result. Even if the proposed system is not put into effect, these areas need investigation so that report literature retrieval may be improved.

Another area needing attention is the human factor in the system. Failures occurred in the retrieval several times because of human error, the most significant being the keypunching operation. This step must be performed accurately—digits transposed or incorrectly punched are a hazard to the entire operation.

But, not all the errors originate with the keypunch operator. He can only punch into the cards the information given him. If that information is incorrect, the fault is not his. In that case the fault usually lies with either the indexer or the cataloger. It is relatively easy to transpose numbers when copying onto a transmittal sheet, and this problem must be watched closely. But even more serious is when two books have the same accession numbers, which upsets the computer program.

Equally important in dealing with the computer at any stage is the realization that all margins must be justified both right and left. Margin justification was not used in this study; therefore, the number 791, for example, sorted out after the number 18210. In future indexing operations this problem must be watched carefully.

Finally, it must be kept in mind that what is retrieved in this study are references to a particular book. Now, somewhere in the particular book might be the desired answer. Finding the answer is still another matter because no page reference is retrieved. The index of the book must still be used to find the exact page or pages desired, and, then, there exists the possibility that it might answer the question in the wrong terms.

Indexing Compatibility

Evaluation of the compatibility of two information or indexing systems can be done on the basis of how well one accepts the vocabulary of the other, assuming both have some common areas of interest. As a result of the work done in this study, the computer was able to compile a list of the subject terms used, along with the accession number and title of the book. Part of this list is given in appendix C. The terms marked with a dash are not used in the NASA subject authority list, but are introduced into the vocabulary of this system. Throughout this study a total of 1596 separate, distinct subject terms or descriptors were used. Of these, some 362 or 23.4 percent did not appear in the thesaurus. However, of these 362, some 127 were found to be acceptable whenever tense, ending, or other slight modifications (such as splitting compound terms) was accomplished. As a result, there were only 235 terms which are not in the NASA thesaurus, or 14.7 percent of the terms assigned.

Examination of the remaining terms showed them to be either very specific terms within a given subject field or very general terms. It was found, for example, that many terms were personal in origin, being a law, principle, or effect named after its discoverer. This was especially true in the areas of physics, chemistry, and mathematics.

As a meausre of compatibility, then, the indexing of the system used in this study was found to be compatible with the NASA MSC report literature indexing since those terms not found in the NASA subject authority list but used in this study could be written off as normal vocabulary growth.

Byproducts

To increase the usefulness of the system and to meet the needs of the user who wishes information on specific topics while in the library, several byproducts from this system are possible. First, the computer could readily print catalog cards. However, since this idea would generate voluminous amount of cards and necessitate additional personnel

for filing, a more practical scheme would be to have printouts of the subject terms used in the system, followed by a listing of the books in which the term would appear (appendix C). This list would allow the user or reference librarian to locate small topics not presently available on catalog cards. Cumulative listings could, however, become prohibitive because of physical size limitations. For this reason they could be readily reduced to microfilm and conveniently coded for user viewing.

It should be stressed that the purpose of this study was not to investigate the usefulness of any byproducts. Usefulness of the items mentioned above must be independently determined, with user attitudes given careful consideration.

APPENDIX A

STAR SUBJECT CATEGORIES

APPENDIX A

STAR SUBJECT CATEGORIES

01	Aerodynamics	Includes aerodynamics of bodies, combinations, internal flow in ducts and turbomachinery; wings, rotors, and control surfaces. For applications see: 02 Aircraft and 31 Space Vehicles. For related information see also: 12 Fluid Mechanics; and 33 Thermodynamics and Combustion.
02	Aircraft	Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics.
03	Auxiliary Systems	Includes fuel cells, energy conversion cells, and solar cells; auxiliary gas turbines; hydraulic, pneumatic, and electrical systems; actuators; and inverters. For related information see also: 09 Electronic Equipment; 22 Nuclear Engineering; and 28 Propulsion Systems.
04	Biosciences	Includes aerospace medicine, exobiology, radiation effects on biological systems; physiological and psychological factors. For related information see also: 05 Biotechnology.

05	Biotechnology	Includes life support systems, human engineering; protective clothing and equipment; crew training and evaluation, and piloting. For related information see also: 04 Biosciences.
06	Chemistry	Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants.
07	Communications	Includes communications equipment and techniques; noise; radio and communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation.
08	Computers	Includes computer operation and programming; and data processing. For basic research see: 19 Mathematics.
09	Electronic Equipment	Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation.
10	Electronics	Includes circuit theory; and feedback and control theory. For applications see: 09 Electronic Equipment. For related information see: Specific Physics Categories.

11	Facilities, Research and Support	Includes airports; lunar and planetary bases including associated vehicles; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands, shock tubes, and wind tunnels); test ranges; and tracking stations.
12	Fluid Mechanics	Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion.
13	Geophysics	Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; and geodesy. For related information see also: 20 Meteorology; 29 Space Radiation; and 30 Space Sciences.
14	Instrumentation and Photography	Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gages; recorders; transducers; aerial photography; and telescopes and cameras.
15	Machine Elements and Processes	Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control, reliability; drafting; and materials fabrication, handling, and inspection.
16	Masers	Includes applications of masers and lasers. For basic research see: 26 Physics, Solid-State.

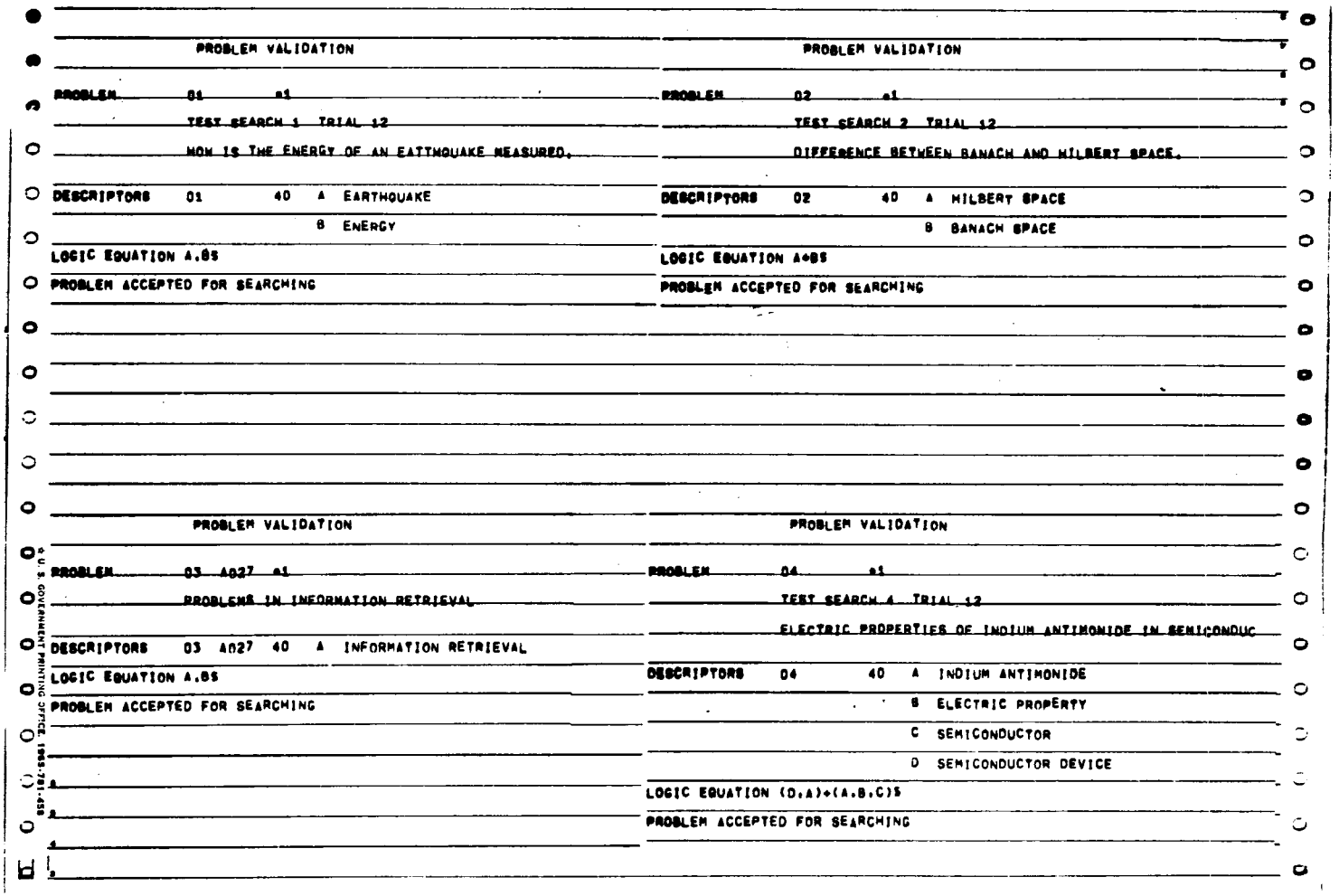
17	Materials, Metallic	Includes cermets; corrosion; physical and mechanical properties of materials; metallurgy; and applications as structural materials. For basic research see: 06 Chemistry. For related information see also: 18 Materials, Nonmetallic; and 32 Structural Mechanics.
18	Materials, Nonmetallic	Includes corrosion; physical and mechanical properties of materials (e.g., plastics); and elastomers, hydraulic fluids, etc. For basic research see: 06 Chemistry. For related information see also: 17 Materials, Metallic; 27 Propellants; and 32 Structural Mechanics.
19	Mathematics	Includes calculation methods and theory; and numerical analysis. For applications see: 08 Computers.
20	Meteorology	Includes climatology; weather forecasting; and visibility studies. For related information see also: 13 Geophysics; and 30 Space Sciences.
21	Navigation	Includes guidance; autopilots; star and planet tracking; inertial platforms; and air traffic control. For related information see also: 07 Communications.
22	Nuclear Engineering	Includes nuclear reactors and nuclear heat sources used for propulsion and auxiliary power. For basic research see: 24 Physics, Atomic, Molecular, and Nuclear. For related information see also: 03 Auxiliary Systems; and 28 Propulsion Systems.

23	Physics, General	Includes acoustics, cryogenics, mechanics, and optics. For astrophysics see: 30 Space Sciences. For geophysics and related information see also: 13 Geophysics, 20 Meteorology, and 29 Space Radiation.
24	Physics, Atomic, Molecular, and Nuclear	Includes atomic, molecular and nuclear physics. For applications see: 22 Nuclear Engineering. For related information see also: 29 Space Radiation.
25	Physics, Plasma	Includes magnetohydrodynamics. For applications see: 28 Propulsion Systems.
26	Physics, Solid-State	Includes semiconductor theory; and superconductivity. For applications see: 16 Masers. For related information see also: 10 Electronics.
27	Propellants	Includes fuels; igniters; and oxidizers. For basic research see: 06 Chemistry; and 33 Thermodynamics and Combustion. For related information see also: 28 Propulsion Systems.
28	Propulsion Systems	Includes air breathing, electric, liquid, solid, and magnetohydrodynamic propulsion. For nuclear propulsion see: 22 Nuclear Engineering. For basic research see: 23 Physics, General; and 33 Thermodynamics and Combustion. For applications see: 31 Space Vehicles. For related information see also: 27 Propellants.

29	Space Radiation	Includes cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts. For related information see also: 13 Geophysics; and 24 Physics, Atomic, Molecular, and Nuclear.
30	Space Sciences	Includes astronomy and astrophysics; cosmology; lunar and planetary flight and exploration; and theoretical analysis or orbit and trajectory. For related information see also: 11 Facilities, Research and Support; and 31 Space Vehicles.
31	Space Vehicles	Includes launch vehicles; manned space capsules; clustered and multistage rockets; satellites; sounding rockets and probes; and operating problems. For basic research see: 30 Space Sciences. For related information see also: 28 Propulsion Systems; and 32 Structural Mechanics.
32	Structural Mechanics	Includes structural element design and weight analysis; fatigue; thermal stress; impact phenomena; vibration; flutter; inflatable structures; and structural tests. For related information see also: 17 Materials, Metallic; and 18 Materials, Nonmetallic.
33	Thermodynamics and Combustion	Includes ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; and combustion theory. For related information see also: 12 Fluid Mechanics; and 27 Propellants.
34	General	Includes reports of a broad nature related to industrial applications and technology, and to basic research; defense aspects; law and related legal matters; and legislative hearings and documents.

APPENDIX B

RETRIEVAL PRINTOUTS



PROBLEM VALIDATION

PROBLEM 01 a1

TEST SEARCH 1 TRIAL 12

HOW IS THE ENERGY OF AN EARTHQUAKE MEASURED.

DESCRIPTORS 01 40 A EARTHQUAKE

B ENERGY

LOGIC EQUATION A.BS

PROBLEM ACCEPTED FOR SEARCHING

PROBLEM VALIDATION

PROBLEM 02 a1

TEST SEARCH 2 TRIAL 12

DIFFERENCE BETWEEN BANACH AND HILBERT SPACE.

DESCRIPTORS 02 40 A HILBERT SPACE

B BANACH SPACE

LOGIC EQUATION A+BS

PROBLEM ACCEPTED FOR SEARCHING

PROBLEM VALIDATION

PROBLEM 03 A027 a1

PROBLEMS IN INFORMATION RETRIEVAL

DESCRIPTORS 03 A027 40 A INFORMATION RETRIEVAL

LOGIC EQUATION A.BS

PROBLEM ACCEPTED FOR SEARCHING

PROBLEM VALIDATION

PROBLEM 04 a1

TEST SEARCH 4 TRIAL 12

ELECTRIC PROPERTIES OF INDIUM ANTIMONIDE IN SEMICONDUC

DESCRIPTORS 04 40 A INDIUM ANTIMONIDE

B ELECTRIC PROPERTY

C SEMICONDUCTOR

D SEMICONDUCTOR DEVICE

LOGIC EQUATION (D.A)+(A.B.C)S

PROBLEM ACCEPTED FOR SEARCHING

PROBLEM VALIDATION

PROBLEM 05 01

TEST SEARCH 5 TRIAL 1

RHEOLOGICAL PROPERTIES OF ASPHALT SYSTEMS.

LOGICAL EQUATION MODIFIED. TERM SYSTEM OMITTED.

DESCRIPTORS 05 40 A ASPHALT

B RHEOLOGY

LOGIC EQUATION A.B$

PROBLEM ACCEPTED FOR SEARCHING

PROBLEM VALIDATION

PROBLEM 06 01

TEST SEARCH 6 TRIAL 1

OPERATION OF LIQUID HELIUM CRYOSTAT.

DESCRIPTORS 06 40 A LIQUID HELIUM

B CRYOSTAT

LOGIC EQUATION A.B$

PROBLEM ACCEPTED FOR SEARCHING

PROBLEM VALIDATION

PROBLEM 07 01

TEST SEARCH 7 TRIAL 1

EVERYTHING ABOUT COMMUNICATIONS SATELLITES.

DESCRIPTORS 07 40 A COMMUNICATIONS SATELLITE

B COMMUNICATIONS

C SATELLITE

D SATELLITE COMMUNICATION

E SYNCHRONOUS COMMUNICATI

LOGIC EQUATION A+D+E+(B.C)$

PROBLEM ACCEPTED FOR SEARCHING

PROBLEM VALIDATION

PROBLEM 08 01

TEST SEARCH 8 TRIAL 1

DIENE AND TRIENE UNDERGOING PHOTOCHEMICAL REACTIONS.

DESCRIPTORS 08 40 A PHOTOCHEMICAL REACTION

B PHOTOCHEMISTRY

C DIENE

D TRIENE

LOGIC EQUATION A+B+C+D$

PROBLEM ACCEPTED FOR SEARCHING

U.S. GOVERNMENT PRINTING OFFICE: 1982-781-458

PROBLEM VALIDATION

PROBLEM 08 01

MEASUREMENT OF ELECTRIC MOMENT USING SUSCEPTIBILITY.

DESCRIPTORS 09 40 A QUANTUM MECHANICS
B QUANTUM THEORY
C MEASUREMENT
D SUSCEPTIBILITY
E ELECTRIC MOMENT

LOGIC EQUATION D.(A+B)+(C.E)$

PROBLEM ACCEPTED FOR SEARCHING

PROBLEM VALIDATION

PROBLEM 10 01

TEST SEARCH 10 TRIAL 1

RELATION OF AFFINE CONNECTION TO FUNDAMENTAL TENSOR IN

DESCRIPTORS 10 40 A UNIFIED FIELD THEORY
B AFFINE CONNECTION
C FUNDAMENTAL TENSOR

LOGIC EQUATION A+B+C$

PROBLEM ACCEPTED FOR SEARCHING

PROBLEM VALIDATION

PROBLEM 11 01

TEST SEARCH 11 TRIAL 1

VIBRARION ANALYSIS USED IN STRUCTURAL DESIGN OF SPACEC

DESCRIPTORS 11 40 A VIBRATION
B ANALYSIS
C SPACECRAFT DESIGN
D SPACECRAFT STRUCTURE
E DESIGN
F STRUCTURAL DESIGN
G SPACECRAFT
H STRUCTURAL ENGINEERING

LOGIC EQUATION (A.B.C)+(A.B.D.E)+(A.B.F.C)+(H.D.E)+H.C$

PROBLEM ACCEPTED FOR SEARCHING

PROBLEM VALIDATION

PROBLEM 12 01

TEST SEARCH 12 TRIAL 1

METHODS OF RETARDING FOOD SPOILAGE BY BACTERIA.

DESCRIPTORS 12 40 A FOOD
B PRESERVATION
C METHOD
D BACTERIA

LOGIC EQUATION A.B.(C+D)$

PROBLEM ACCEPTED FOR SEARCHING

PROBLEM VALIDATION

PROBLEM 13 01

TEST SEARCH 13 TRIAL 1

SADDLEPOINT METHOD FOR ASYMPTOTIC EXPANSION OF DIFFERE

DESCRIPTORS	13	40	A	DIFFERENTIAL EQUATION
			B	ASYMPTOTIC METHOD
			C	EXPANSION
			D	SADDLEPOINT METHOD

LOGIC EQUATION D*(A,B,C)$

PROBLEM ACCEPTED FOR SEARCHING

PROBLEM VALIDATION

PROBLEM 14 01

TEST SEARCH 14 TRIAL 1

DIELECTRIC DISPERSION OF POLYVINYL ACETATE IN TOLUENE.

DESCRIPTORS	14	40	A	POLAR SOLUTION
			B	DIELECTRIC
			C	DISPERSION
			D	DIELECTRIC POLARIZATION
			E	POLYVINYL ACETATE
			F	TOLUENE

LOGIC EQUATION (B,C),(E,F)*(A,C),(E,F)*D,(E,F)$

PROBLEM ACCEPTED FOR SEARCHING

PROBLEM VALIDATION

PROBLEM 15 01

TEST SEARCH 15 TRIAL 1

WHAT IS BURGER,S MODEL FOR TURBULENCE.

DESCRIPTORS	15	40	A	BURGER MODEL
			B	TURBULENCE
			C	MODEL
			D	STABILITY THEORY

LOGIC EQUATION A*B*(C,D)$

PROBLEM ACCEPTED FOR SEARCHING

PROBLEM VALIDATION

PROBLEM 16 01

TEST SEARCH 16 TRIAL 1

ANNEALING ON VANADIUM-NIOBIUM ALLOYS.

DESCRIPTORS	16	40	A	VANADIUM
			B	VANADIUM ALLOY
			C	NIOBIUM
			D	NIOBIUM ALLOY
			E	ALLOY

LOGIC EQUATION A,C,E,(B*D)$

PROBLEM ACCEPTED FOR SEARCHING

PROBLEM VALIDATION

PROBLEM 17 01

ST SEARCH 17 TRIAL 1

CALIBRATION OF DTA APPARATUS.

DESCRIPTORS 17 40 A DIFFERENTIAL THERMAL AN
B APPARATUS
C EQUIPMENT
D CALIBRATION

LOGIC EQUATION A.D.(C+B)$

PROBLEM ACCEPTED FOR SEARCHING

PROBLEM VALIDATION

PROBLEM 18 01

TEST SEARCH 18 TRIAL 1

CLEAR MAGNETIC RESONANCE SPECTROSCOPY FOR IDENTIFYING

DESCRIPTORS 18 40 A NUCLEAR MAGNETIC RESONANCE
B NUCLEAR SPECTROSCOPY
E ORGANIC COMPOUND
F IDENTIFICATION

LOGIC EQUATION A+B+(E,F)$

PROBLEM ACCEPTED FOR SEARCHING

MSC INFORMATION RETRIEVAL SYSTEM ••••

TECHNICAL INFORMATION DISSEMINATION BRANCH

SEARCH QUESTION ••••
TEST SEARCH 1 TRIAL 12
HOW IS THE ENERGY OF AN EATTHQUAKE MEASURED.

PREPARED BY-

SEARCH NUMBER 01 12 AUG 66

••••••••••••••••••••••••••••••••••••
ACCESSION NO. 18081 ISSUE CATEGORY 13

TITLE SEISMICITY OF THE EARTH AND ASSOCIATED PHENOME
NA. (2D ED.)

IMPRINT NEW YORK, HAFNER PUB. CO., 1965 (C1954)
BIBLIOGRAPHY: P.112-138.

AUTHORS GUTENBERG, B. RICHTER, C. F.

CALL NUMBER QE 534.G98

SUBJECT TERMS

EARTHQUAKE	SHOCK WAVE	CLASSIFICATION
FREQUENCY	ENERGY	REGION
AREA	SEISMOLOGY	SEISMIC ACTIVITY
MECHANISM	TSUNAMIS	MARGINAL FRACTURE
STABLE MASS	RIFT ZONE	

NSC INFORMATION RETRIEVAL SYSTEM ****

TECHNICAL INFORMATION DISSEMINATION BRANCH

SEARCH QUESTION ****
TEST SEARCH 2 TRIAL 12
DIFFERENCE BETWEEN BANACH AND HILBERT SPACE.

PREPARED BY-

SEARCH NUMBER 82 12 AUG 66

****
ACCESSION NO. 18080 ISSUE CATEGORY 19

TITLE UNBOUNDED LINEAR OPERATORS: THEORY AND APPLICATIONS.

IMPRINT NEW YORK , MCGRAW-HILL (C1966) (MCGRAW-HILL SERIES IN HIGHER MATHEMATICS)

AUTHORS GOLDBERG, SEYMOUR

CALL NUMBER QA 251.G56

SUBJECT TERMS

UNBOUNDED	LINEAR	OPERATOR
NORMED	LINEAR SPACE	HILBERT SPACE
THEORY	SINGULAR OPERATOR	CLOSED
RANGE	PERTURBATION THEORY	DIRICHLET PROBLEM
DIRICHLET OPERATOR	DIFFERENTIAL EQUATION	APPLICATION

NSC INFORMATION RETRIEVAL SYSTEM ****

TECHNICAL INFORMATION DISSEMINATION BRANCH

SEARCH QUESTION ****
TEST SEARCH 4 TRIAL 12
ELECTRIC PROPERTIES OF INDIUM ANTIMONIDE IN SEMICONDUCTOR.

PREPARED BY-

SEARCH NUMBER 04 12 AUG 66

****
ACCESSION NO. 18088 ISSUE CATEGORY 18

TITLE MATERIALS USED IN SEMICONDUCTOR DEVICES

IMPRINT NEW YORK, INTERSCIENCE PUBLISHERS (C1965)

AUTHORS HOGARTH, C. A. (ED.)

CALL NUMBER QC 612.S4 H66

SUBJECT TERMS

SEMICONDUCTOR DEVICE	SEMICONDUCTOR	MATERIAL
GERMANIUM	PREPARATION	PROPERTY
STRUCTURE	APPLICATION	SILICON
SELENIUM	LEAD SULFIDE	SELENIDE
TELLURIDE	INDIUM ANTIMONIDE	BISMUTH TELLURIDE
CADIUM ANTIMONIDE	ZINC ANTIMONIDE	

MSC INFORMATION RETRIEVAL SYSTEM ****

TECHNICAL INFORMATION DISSEMINATION BRANCH

SEARCH QUESTION ****
TEST SEARCH 5 TRIAL 1
RHEOLOGICAL PROPERTIES OF ASPHALT SYSTEMS.
LOGICAL EQUATION MODIFIED. TERM SYSTEM OMITTED.

PREPARED BY-

SEARCH NUMBER 05 12 AUG 66

ACCESSION NO. 1A100 8 ISSUE CATEGORY 17

TITLE COMPOSITE MATERIALS

IMPRINT AMSTERDAM, ELSEVIER PUB. CO., 1964. (ELSEVIER MATERIALS SCIENCE SERIES)

AUTHORS HOLLIDAY, LESLIE (ED.)

CALL NUMBER TA 403.H72

SUBJECT TERMS

GLASS	INORGANIC	RESIN
GLASS-RESIN	KEYING	COMPLING
AGENT	THERMOPLASTIC	THERMOPLASTIC-RUBBER
THERMOPLASTIC-GAS	FOAM	GEOMETRY
ELASTOMER	FILLER	CONCRETE
RHEOLOGY	ASPHALT	PAPER
CELLULOSE	FIBER	

NSC INFORMATION RETRIEVAL SYSTEM ****

TECHNICAL INFORMATION DISSEMINATION BRANCH

SEARCH QUESTION ****
TEST SEARCH 6 TRIAL 1
OPERATION OF LIQUID HELIUM CRYOSTAT.

PREPARED BY-

SEARCH NUMBER 06 12 AUG 66

****
ACCESSION NO. 18078 ISSUE CATEGORY 23

TITLE EXPERIMENTAL PHYSICS AT LOW TEMPERATURES, AN I
NTRODUCTORY SURVEY

IMPRINT DETROIT, WAYNE STATE UNIV. PRESS, 1966.
INCLUDES BIBLIOGRAPHICAL REFERENCES.

AUTHORS MACKINNON, LACHLAN.

CALL NUMBER QC 278.M19

SUBJECT TERMS

LOW-TEMPERATURE PHYSICS	TECHNIQUE	LIQUID HELIUM
SUPERCONDUCTIVITY	METAL	CRYOSTAT
LIQUID HELIUM II	CRYOGENIC EQUIPMENT	SPECIFIC HEAT
MEASUREMENT	ADIABATIC DEMAGNETIZATI	CRYOGENICS
TWO FLUID MODEL	INTERNAL CONVECTION	LANDAU-TELLER THEORY
ISOTOPE	FEYMAN THEORY	VORTEX GENERATION
MIXTURE	THERMODYNAMICS	ENERGY LEVEL
FREE ELECTRON	MODEL	FERMI SURFACE
PHONON	ELECTRON COLLISION	ELECTRONIC PROPERTY
ELECTRON ORBIT	MAGNETIC FIELD	LANDAU LEVEL

MSC INFORMATION RETRIEVAL SYSTEM ••••

TECHNICAL INFORMATION DISSEMINATION BRANCH

SEARCH QUESTION ••••
TEST SEARCH 7 TRIAL 1
EVERYTHING ABOUT COMMUNICATIONS SATELLITES,

PREPARED BY•

SEARCH NUMBER 07 12 AUG 66

••

ACCESSION NO. 17248 ISSUE CATEGORY 31

TITLE RELIABILITY IN SPACE VEHICLES.

IMPRINT ELIZABETH, N.J., ENGINEERING PUBLISHERS (C1965
BASED ON SEMINAR ON RELIABILITY IN SPACE
VEHICLES, APRIL 2, 1965. SPONSORED BY LOS
ANGELES SECTION, COMPONENT PARTS AND RELIABILI
TY GROUPS OF INSTITUTE OF ELECTRICAL AND
ELECTRONICS ENGINEERS.

AUTHORS ROTH, CHARLES E. RYERSON, C. M. CONNOR, JOHN A.

CALL NUMBER TL 885.543

SUBJECT TERMS

SPACE VEHICLE	RELIABILITY	RELIABILITY ENGINEERING
PROGRAM MANAGEMENT	MATHEMATICAL	METHOD
COMPONENT RELIABILITY	COMPONENT	SELECTION
DEGRADATION	ANALYSIS	FACTOR
STRUCTURAL RELIABILITY	PRODUCT	MANAGEMENT
SYNCHRONOUS COMMUNICATI	MICROELECTRONICS	SYNCHRONOUS SATELLITE S
FAILURE MODE	MECHANISM	CONTRACT AWARD

NSC INFORMATION RETRIEVAL SYSTEM ****

TECHNICAL INFORMATION DISSEMINATION BRANCH

SEARCH QUESTION ****

TEST SEARCH 8 TRIAL 1

DIENE AND TRIENE UNDERGOING PHOTOCHEMICAL REACTIONS.

PREPARED BY-

SEARCH NUMBER 08 12 AUG 66

ACCESSION NO. 18214 ISSUE CATEGORY 06

TITLE ADVANCES IN PHOTOCHEMISTRY, VOLUME 4, (EDITED BY) ALBERT W. NOYES AND OTHERS.

IMPRINT NEW YORK, INTERSCIENCE PUBLISHERS, 1966.

AUTHORS NOYES, ALBERT W. (ED.) HAMMOND, GEORGE S. PITTS, J. N.

CALL NUMBER QD 601.AD9

SUBJECT TERMS

PHOTOCHEMISTRY	MECHANISM	COMPLEX
KINETICS	ALDEHYDE	OXIDATION
ENERGY LEVEL	IDENTIFICATION	AROMATIC COMPOUND
PHOTOCHEMICAL REARRANGE	CONJUGATE	CYCLIC KEYTONE
DIENE	TRIENE	SULFUR
REACTION	PHOTOCHEMICAL TRANSFORM	POLYENIC COMPOUND
PHOTOLYSIS	DIAZIRINE	PHOTOCHEMICAL REACTION
CYCLIC HYDROCARBON		

NSC INFORMATION RETRIEVAL SYSTEM ****

TECHNICAL INFORMATION DISSEMINATION BRANCH

SEARCH QUESTION ****
TEST SEARCH 10 TRIAL 1
RELATION OF AFFINE CONNECTION TO FUNDAMENTAL TENSOR IN FIELD THEOR

PREPARED BY-

SEARCH NUMBER 10 12 AUG 66

****
ACCESSION NO. 18097 ISSUE CATEGORY 19

TITLE EINSTEIN'S UNIFIED FIELD THEORY. WITH A PREFAC
E BY ANDRE LICHNEROWICZ. TRANSLATED FROM THE F
RENCH BY RICHARD AKERIB.

IMPRINT NEW YORK, GORDON AND BREACH (C1966)
TRANSLATION OF LA THEORIE DU CHAMP UNIFIE
D'EINSTEIN ET QUELQUESUNS DE SES DEVELOPPE-
MENTS.
BIBLIOGRAPHY: P.179-83.

AUTHORS TONNELAT, M. A.

CALL NUMBER QC 6.5 T61

SUBJECT TERMS

UNIFIED FIELD THEORY	GEOMETRICAL SYNTHESIS	AFFINE CONNECTION
FUNDAMENTAL TENSOR	GENERAL RELATIVITY	RANK TWO
FIELD EQUATION	VARIATIONAL PRINCIPLE	CONSERVATION EQUATION
SPHERICALLY SYMETRICAL	SOLUTION	RICCI TENSOR
ISOTROPIC COORDINATE	RELATION	DETERMINANT
EINSTEIN EQUATION	SCHOEDINGER THEORY	FOUR-DIMENSIONAL THEORY
HIGHER-DIMENSIONAL THEO	BORN-INFELD THEORY	NONLINEAR
DISPLACEMENT	ENERGY-MOMENTUM TENSOR	RIEMANN SPACE

NSC INFORMATION RETRIEVAL SYSTEM ****

TECHNICAL INFORMATION DISSEMINATION BRANCH

SEARCH QUESTION ****
TEST SEARCH 11 TRIAL 1
VIBRARION ANALYSIS USED IN STRUCTURAL DESIGN OF SPACECRAFT.

PREPARED BY-

SEARCH NUMBER 11 12 AUG 66

ACCESSION NO. 14094 ISSUE CATEGORY 32

TITLE SPACECRAFT STRUCTURES

IMPRINT ENGLEWOOD CLIFFS, N.J., PRENTICE-HALL (C1966)
(PRENTICE-HALL INTERNATIONAL SERIES IN SPACE TECHNOLOGY)

AUTHORS OSGOOD, CARL C.

CALL NUMBER TL 790.OS3

SUBJECT TERMS

SPACECRAFT DESIGN	SPACECRAFT CONSTRUCTION	SPACECRAFT CONFIGURATIO
SPACECRAFT INSTRUMENTAT	SPACECRAFT STRUCTURE	SPACECRAFT ENVIRONMENT
LAUNCHING	ENROUTE	OPERATIONAL
SPACECRAFT	SPACECRAFT REENTRY	LANDING
CRITERION	METHOD	RIGIDITY
RELIABILITY	THERMAL FLUX	VIBRATION
ANALYSIS	MODAL COUPLING	DAMPING
FATIGUE	SHOCK	BUCKLING
FABRICATION	HONEYCOMB	LAMINATED MATERIAL
SANDWICH CONSTRUCTION	STRUCTURAL ANALYSIS	STRUCTURAL DESIGN

NBC INFORMATION RETRIEVAL SYSTEM ****

TECHNICAL INFORMATION DISSEMINATION BRANCH

SEARCH QUESTION ****
TEST SEARCH 13 TRIAL 1
SADDLEPOINT METHOD FOR ASYMPTOTIC EXPANSION OF DIFFERENTIAL EQUATN

PREPARED BY-

SEARCH NUMBER 13 12 AUG 66

****
ACCESSION NO. 18089 ISSUE CATEGORY 19

TITLE ASYMPTOTIC EXPANSIONS FOR ORDINARY DIFFERENTIA
L EQUATIONS

IMPRINT NEW YORK, INTERSCIENCE PUBLISHERS (C1965)
(PURE AND APPLIED MATHEMATICS, A SERIES OF
TEXTS AND MONOGRAPHS, V.14)

AUTHORS WASOW, WOLFGANG

CALL NUMBER QA 372.W28

SUBJECT TERMS

DIFFERENTIAL EQUATION	ASYMPTOTIC SERIES	ASYMPTOTIC EXPANSION
POWER SERIES	TRANSITION POINT	PERTURBATION
PARAMETER	NONLINEAR EQUATION	FACTORIAL SERIES
JORDAN FORM	ASYMPTOTIC METHOD	BOUNDARY VALUE PROBLEM
SADDLEPOINT METHOD	LAPLACE TRANSFORM	AIRY EQUATION

MSC INFORMATION RETRIEVAL SYSTEM ****

TECHNICAL INFORMATION DISSEMINATION BRANCH.

SEARCH QUESTION ****

TEST SEARCH 15 TRIAL 1
WHAT IS BURGER,S MODEL FOR TURBULENCE.

PREPARED BY-

SEARCH NUMBER 15 12 AUG 66

****

ACCESSION NO. 18205 ISSUE CATEGORY 19

TITLE STUDIES IN NON-LINEAR STABILITY THEORY

IMPRINT BERLIN, NEW YORK, SPRINGER-VERLAG, 1965.
(SPRINGER TRACTS IN NATURAL PHILOSOPHY, V.6)
BIBLIOGRAPHY: P. 114-15.

AUTHORS ECKHAUS, WIKTOR

CALL NUMBER QA 871.E3

SUBJECT TERMS

STABILITY	PROBLEM	THEORY
NONLINEAR	ONE-DIMENSIONAL SPACE	GREEN FUNCTION
ASYMPTOTIC METHOD	SERIES EXPANSION	EIGENFUNCTION
BURGERS MODEL	TURBULENCE	TWO-DIMENSIONAL SPACE
FOURIER SERIES	PERTURBATION	PERIODIC SOLUTION
POISEUILLE FLOW		

U.S. GOVERNMENT PRINTING OFFICE 1965-781-498

NSC INFORMATION RETRIEVAL SYSTEM ****

TECHNICAL INFORMATION DISSEMINATION BRANCH

SEARCH QUESTION ****
TEST SEARCH 18 TRIAL 1
CLEAR MAGNETIC RESONANCE SPECTROSCOPY FOR IDENTIFYING ORGANIC COMP

PREPARED BY-

SEARCH NUMBER 18 12 AUG 66

ACCESSION NO. 18073 ISSUE CATEGORY 06

TITLE SPECTROSCOPIC TECHNIQUES IN ORGANIC CHEMISTRY

IMPRINT LONDON, HEYDEN, 1965. (SPECTROSCOPY IN EDUCATION, VOL.2)

AUTHORS BAKER, A. J. CAIRNS, T.

CALL NUMBER QD 281,S1 B17

SUBJECT TERMS

SPECTROSCOPY	TECHNIQUE	ORGANIC CHEMISTRY
INFARED SPECTROSCOPY	NUCLEAR MAGNETIC RESONA	NUCLEAR SPECTROSCOPY
MASS SPECTROSCOPY	ULTRAVIOLET SPECTROSCOP	EXPERIMENT
SPECTROSCOPIC ANALYSIS		

APPENDIX C

SUBJECT INDEX FOR BOOKS

SUBJECT INDEX FOR BOOKS

SUBJECT TERM	BOOK TITLE	PAGE 1
1056		
ABSORPTION		
16746	SOLAR RADIATION, EDITED BY N. ROBINSON.	
17394	MODERN METHODS OF CHEMICAL ANALYSIS. BY J. A. BARNARD AND R. CHAVEN.	
18209	SPECTROSCOPIC ANALYSIS OF GAS MIXTURES, BY D. P. BOCHKOVA AND E. YA SHREYDER, EDITED BY S. E. FRISCH.	
ABUNDANCE		
19004	ADVANCES IN ECOLOGICAL RESEARCH, VOL. 3.	
ACCELERATION		
18211	GAS TURBINE FUEL CONTROLS ANALYSIS AND DESIGN	
ACCELEROMETER		
14947	GUIDANCE AND CONTROL OF AEROSPACE VEHICLES,EDITED BY CORNELIUS T. LEONARDS AND OTHERS.	
ACETATE		
18083	ESSAYS IN BIOCHEMISTRY, VOLUME 2.	
ACETYLENE		
18072 B	OXIDATION IN ORGANIC CHEMISTRY	
ACID		
003	DIBASIC ACIDS AND ANHYDRIDES	
014	CHEMICALS USED IN FOOD PROCESSING.	
17450	THE INVESTIGATION OF ORGANIC REACTIONS	
ACIDITY		
18085	THERMOBACTERIOLOGY IN FOOD PROCESSING.	
ACKERET THEORY		
701	MISSLE AERODYNAMICS.	
ACOUSTIC		
001	RESEARCH ON THE NATURE OF MINERAL-FORMING SOLUTIONS WITH SPECIAL REFERENCE TO DATA FROM FLUID INCLUSIONS, TRANS. BY N	

SUBJECT INDEX FOR BOOKS

SUBJECT TERM	BOOK TITLE	PAGE 2
ACTIVE		
14567 B	GUIDANCE AND CONTROL OF AEROSPACE VEHICLES,EDITED BY CORNELIUS T. LEONADES AND OTHERS,	
ACTIVITY		
18075	INTRODUCTION TO CHEMICAL THERMODYNAMICS	
18076	ADVANCES IN CHROMATOGRAPHY, VOLUME 1, EDITED BY J. CALVIN GIDDINGS AND ROY A. KELLER,	
ADAPTATION		
012	THE NEUROENDOCRINE CONTROL OF ADAPTATION,	
ADDITIVE		
014	CHEMICALS USED IN FOOD PROCESSING,	
ADENOVIRUS		
18088	INFLUENZA AND OTHER VIRUS INFECTIONS OF THE RESPIRATORY TRACT, 2D, ED	
ADIABATIC DEMAGNETIZATI		
18078	EXPERIMENTAL PHYSICS AT LOW TEMPERATURES, AN INTRODUCTORY SURVEY	
ADIABATIC INVARIANT		
10618	ELEMENTS OF PLASMA PHYSICS	
ADIABATIC MOTION		
13638	PLASMA PHYSICS	
ADIPIC		
003	DIBASIC ACIDS AND ANHYDRIDES	
ADIPOSE TISSUE		
18083	ESSAYS IN BIOCHEMISTRY, VOLUME 2,	
ADRENAL CORTEX		
012	THE NEUROENDOCRINE CONTROL OF ADAPTATION,	

REFERENCES

1. Vickery, B. C.: On Retrieval System Theory. Second ed. Butterworths, 1965, p. 150.

2. United States National Bureau of Standards: Automatic Indexing: A State-of-the-Art Report. NBS Monograph 91. Government Printing Office, 1965, p. 2.

3. Jaster, Josephine J.; Murray, Barbara R.; and Taube, Mortimer: The State of the Art of Coordinate Indexing. Documentation Incorporated, 1962, p. 12.

4. Newman, Simon M., ed.: Information Systems Compatibility. Spartan Books, 1965, p. 7.

5. Bourne, Charles P.: Methods of Information Handling. John Wiley, 1963, pp. 33-37.

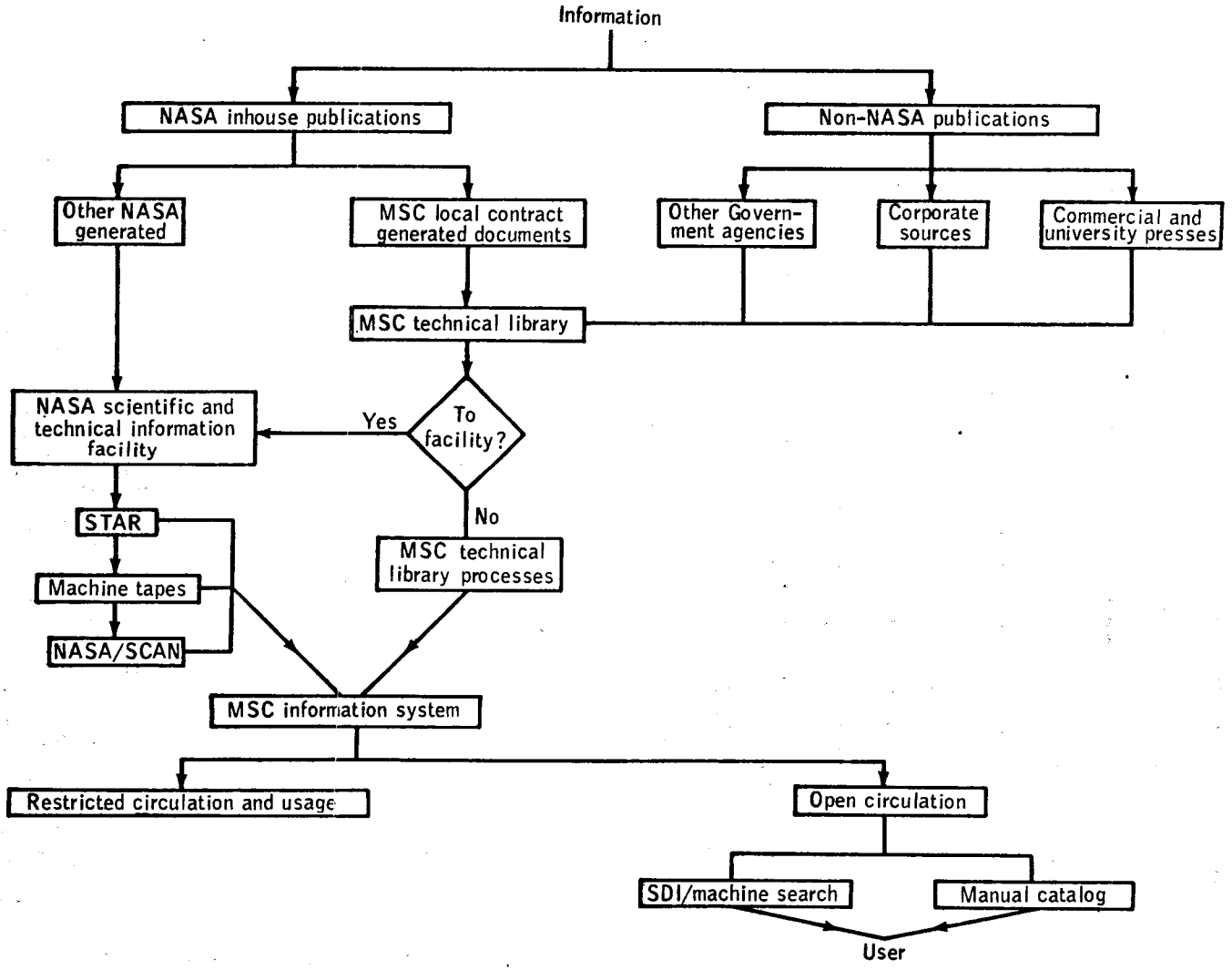


Figure 1.- Flow of information to the user at NASA MSC.

SUBJECT AUTHORITY STATISTICS, DP MAY 26, 1966

	ALPHA TERM	TYPE	POST	PUB	NACH	62-3	64-A	-N	-X	65-A	-N	-X	66-A	-N	-X	TOTAL
	ACETYLCHOLINE	3		9	14	1	3			8	6		3	1	1	23
	ACETYLENE	3		54	140	73	13	16	8	17	29	8	9	16	5	194
	ACETYLSALICYLIC	1			1	1										1
	ACETYLSALICYLIC ACID /ASA/	1		1		1										1
	ACHIEVEMENT	1			31	4	6	5	1	3	4		5	2	1	31
	ACHONDRITE	3		15	24	14	6	6	1	4	2	1		4	1	39
	ACID	3		36	1826	350	70	313	58	190	339	138	89	220	86	1862
	ACID-BASE BALANCE	3		16	3		3	1		12	2	1				19
	ACIDITY	1			40	23	4	2	1	1	2		3	0		40
	ACIDOSIS	3		2	22		6			12	1		5			24
	ACOUSTIC	1			860	6	38	66	20	203	153	119	106	78	71	860
	ACOUSTIC ATTENUATION	3		87		24	15	6		16	6	7	6	3	4	87
NO	ACOUSTIC COMBUSTION	3	P													
	ACOUSTIC DUCT	3		6		4	1					1				6
	ACOUSTIC EXCITATION	3		74		8	18	4		19	1	6	10	2	6	74
	ACOUSTIC FATIGUE	3		38			4	7		4		1	19	2	1	38
	ACOUSTIC GENERATOR	3		26		3	6	1		6	3	2	3		2	26
	ACOUSTIC IMPEDANCE	3		34		17	3			5	2	1	5		1	34
NO	ACOUSTIC INSTABILITY	3	P		1									1		1
	ACOUSTIC NOZZLE	3		5		2				1	1		1			5
	ACOUSTIC RADIATION	3		89		30	13	11	2	13	6	4	1	7	2	89
	ACOUSTIC SCATTERING	3		40		3	9	2		11	2	1	6	4	2	40
	ACOUSTIC SIMULATION	3		23	1	4	3			2	3	3	3	5	1	24
	ACOUSTIC STABILITY	3		12			1			2	2	1	2	3	1	12
	ACOUSTIC STREAMING	3		12		5	1			3	1			2		12
	ACOUSTIC VELOCITY	3		19		4	4			4	2	2	1	2		19
	ACOUSTIC VIBRATION	3		134	2	25	26	12	5	32	6	11	7	8	4	136
	ACOUSTICS	3		326	1035	540	127	173	43	51	152	125	13	99	38	1361
NO	ACQUISITION	3	P		769	147	42	68	49	106	115	90	35	54	63	769
	ACRIFLAVINE	1			1						1					1
	ACROBATICS	1			6	3			1		1		1			6
	ACROLEIN	3		3	1						3			1		4
	ACRYLATE	3		13	48	17	2	8	8	13	3	3	3	1	3	61
	ACRYLIC	1			52	3	1	7	4	8	4	8	2	5	10	52
	ACRYLIC ACID	3		10	22	24		4	1		2			1		32
	ACRYLONITRILE	3		8	9	3		3	1	2	3			4	1	17
NO	ACTH	3	P		4									1	3	4
	ACTINIDE	3		13	15	2	1	4		2	11			8		28
	ACTINIUM	3		4	8	2		5			2	1		2		12
	ACTINOGRAPH	1			4	3					1					4

PAGE NO 3

Figure 2.- NASA subject authority list.

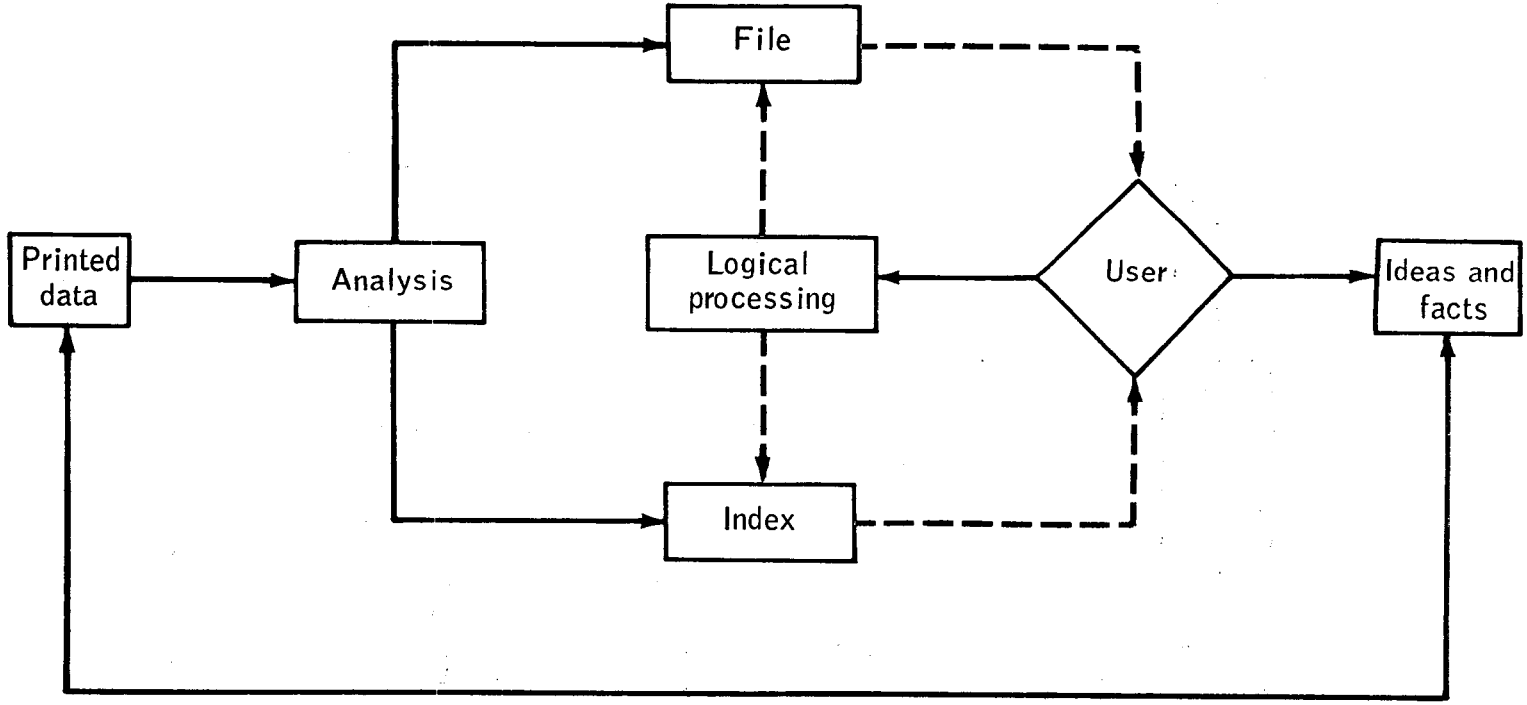


Figure 3.- The information framework.

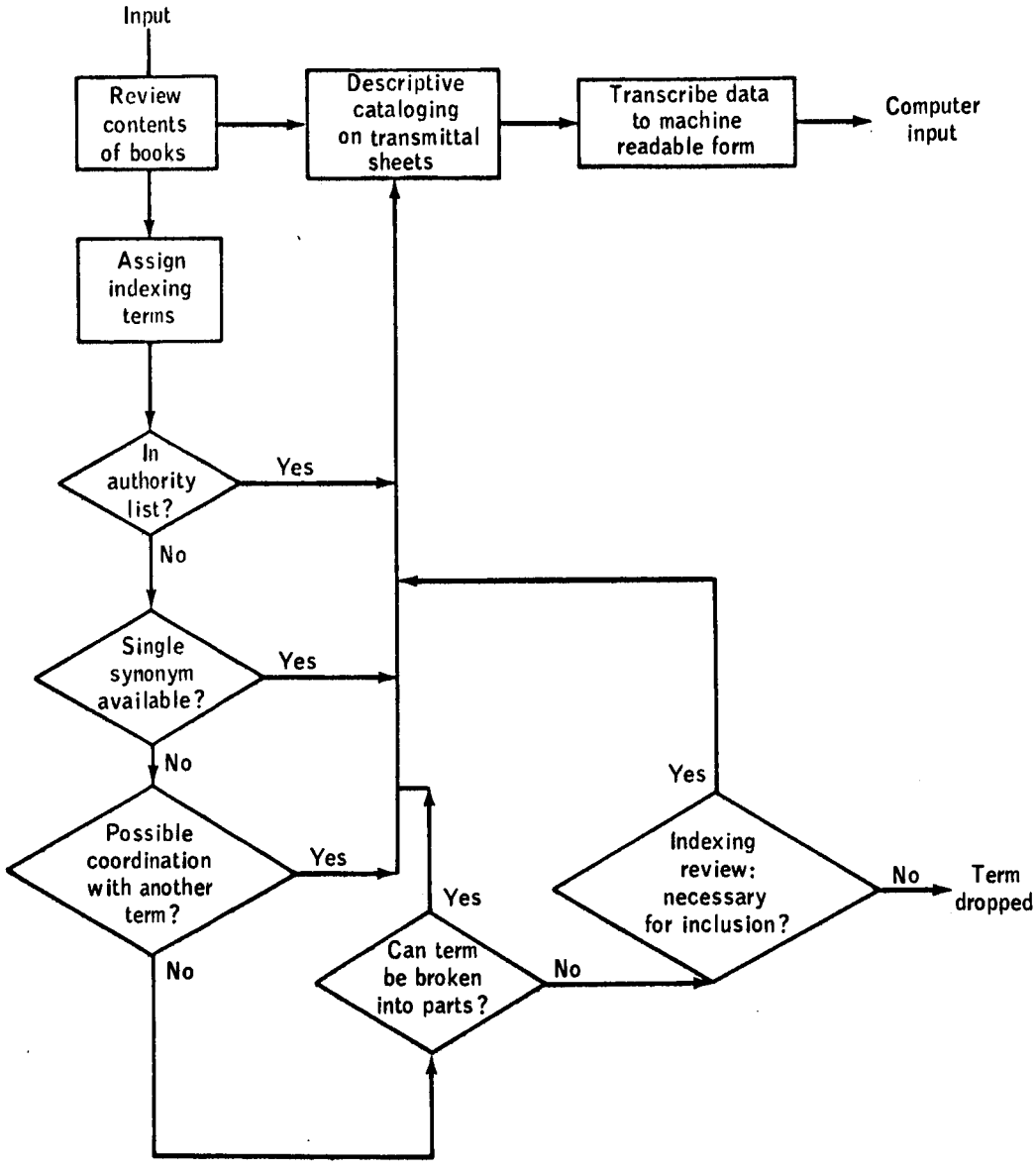
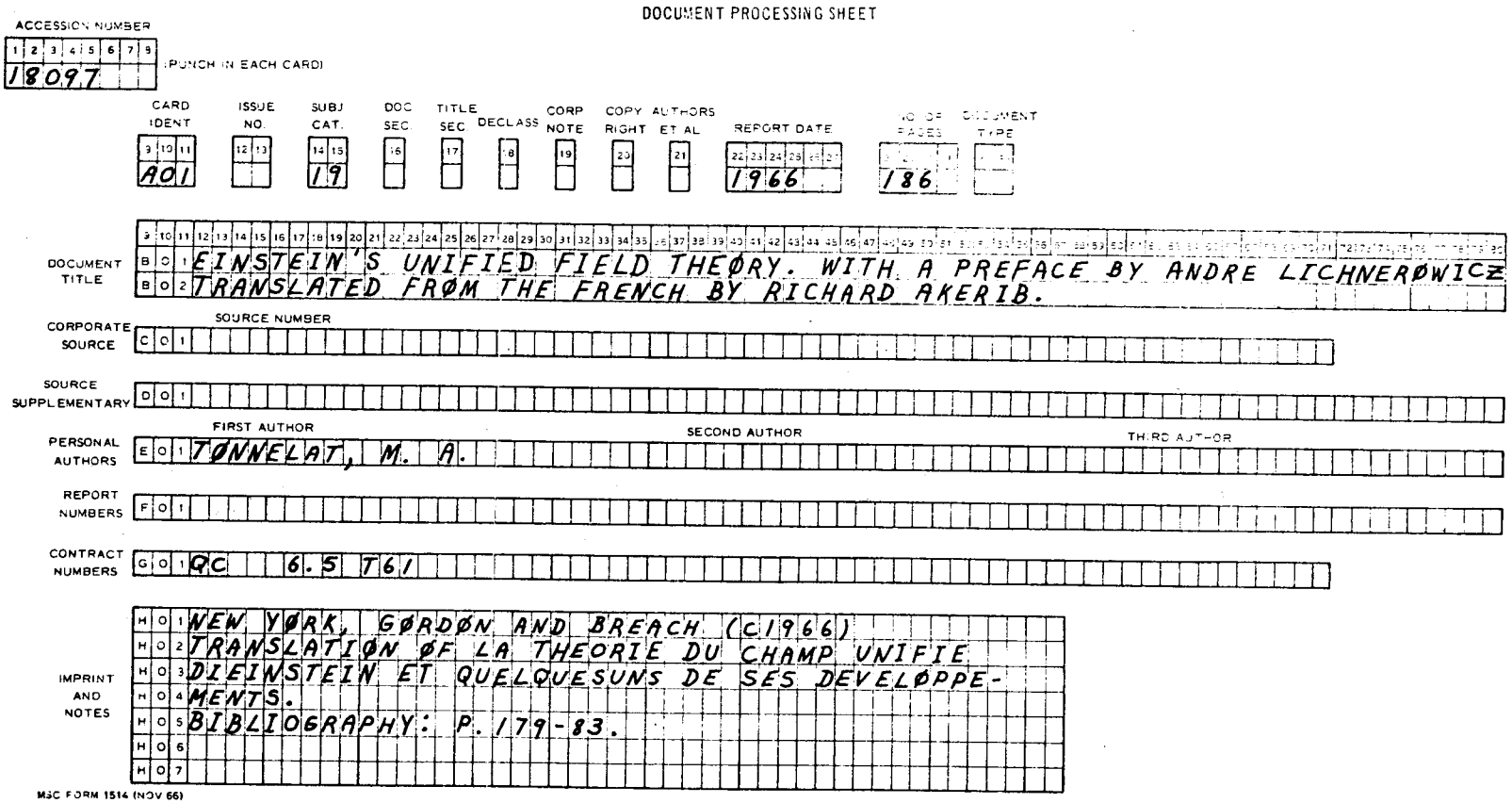


Figure 4.- Flow chart of the indexing procedure.



DOCUMENT PROCESSING SHEET

ACCESSION NUMBER: 18097 (PUNCH IN EACH CARD)

CARD IDENT	ISSUE NO.	SUBJ CAT.	DOC SEC	TITLE SEC	DECLASS	CORP NOTE	COPY RIGHT	AUTHORS ET AL	REPORT DATE	NO. OF PAGES	DOCUMENT TYPE
A01		19							1966	186	

DOCUMENT TITLE
B01 EINSTEIN'S UNIFIED FIELD THEØRY. WITH A PREFACE BY ANDRE LICHNERØWICZ
B02 TRANSLATED FRØM THE FRENCH BY RICHARD AKERIB.

CORPORATE SOURCE (SOURCE NUMBER)
C01

SOURCE SUPPLEMENTARY
D01

PERSONAL AUTHORS (FIRST AUTHOR / SECOND AUTHOR / THIRD AUTHOR)
E01 TØNNELAT, M. A.

REPORT NUMBERS
F01

CONTRACT NUMBERS
G01 QC 6.5 T61

IMPRINT AND NOTES
H01 NEW YØRK, GØRDØN AND BREACH (C1966)
H02 TRANSLATIØN ØF LA THEORIE DU CHAMP UNIFIE
H03 D'EINSTEIN ET QUELQUESUNS DE SES DEVELØPPE-
H04 MENTS.
H05 BIBLIOGRAPHY: P. 179-83.
H06
H07

MSC FORM 1514 (NOV 66)

PAGE 1 OF 2

Figure 5.- Document processing sheet, page 1.

DOCUMENT PROCESSING SHEET

SUBJECT TERMS

ACCESION NUMBER

1	2	3	4	5	6	7	8
/	8	0	9	7			

(PUNCH IN EACH CARD)

DESCRIPTORS

9–11	12–34	35–57	58–80
J01	UNIFIED FIELD THEORY	GEØMETRICAL SYNTHESIS	AFFINE CØNNECTIØN
J02	FUNDAMENTAL TENSØR	GENERAL RELATIVITY	RANK TWØ
J03	FIELD EQUATIØN	VARIATIØNAL PRINCIPLE	CØNSERVATIØN EQUATIØN
J04	SPHERICALLY SYMETRICAL	SØLUTIØN	RICCI TENSØR
J05	ISØTRØPIC CØØRDINATE	RELATIØN	DETERMINANT
J06	EINSTEIW EQUATIØN	SCHØEDINGER THEØRY	FØUR-DIMENSIØNAL THEØRY
J07	HIGHER-DIMENSIØNAL THEØ	BØRN-INFELD THEØRY	NØNLINEAR
J08	DISPLACEMENT	ENERGY-MØMENTUM TENSØR	RIEMANN SPACE
J09			
J10			

MSC FORM 1514 (NOV 66)

PAGE 2 OF 2

Figure 6.- Document processing sheet, page 2.

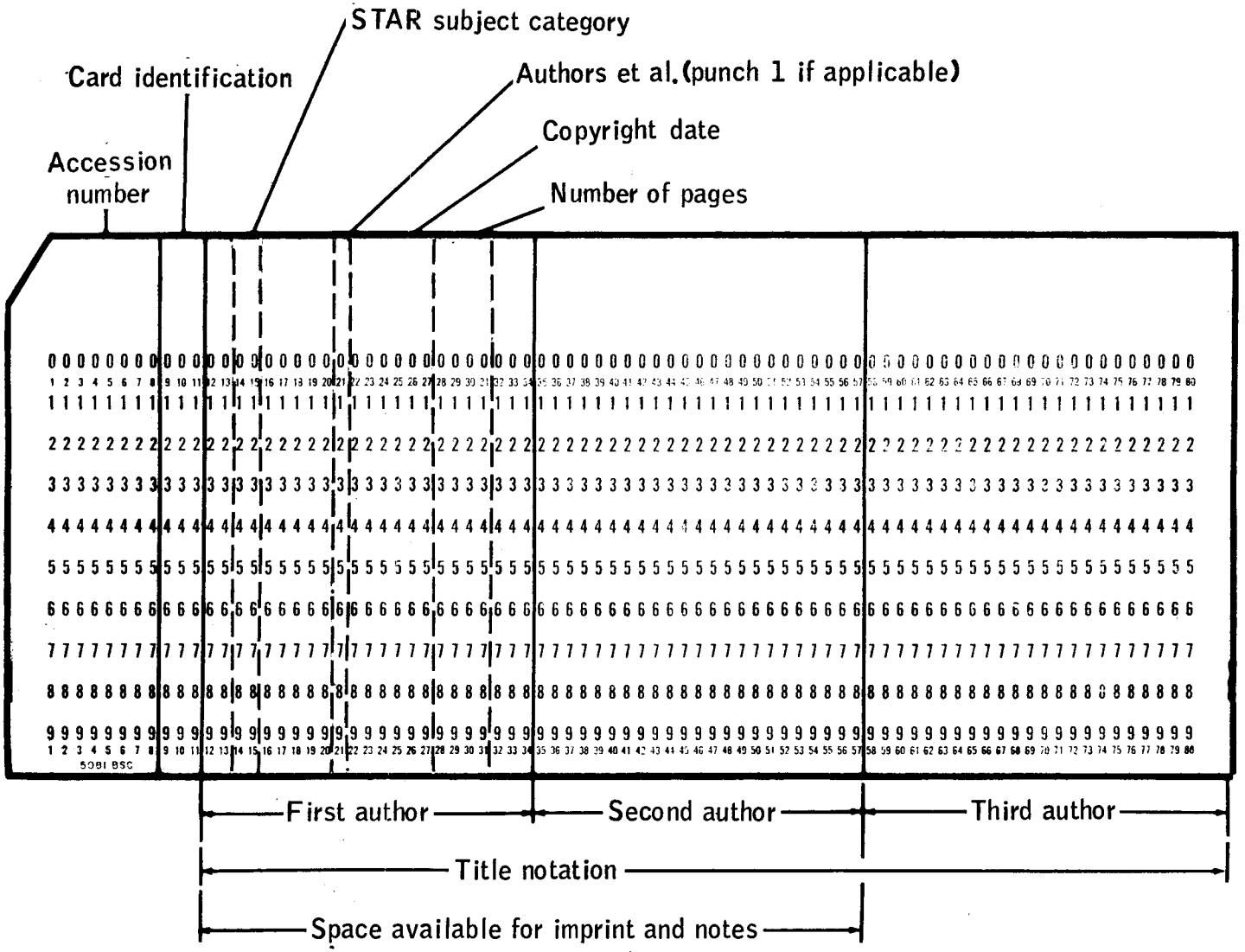


Figure 7.- Data fields on punched card corresponding to format of document processing sheet, page 1.

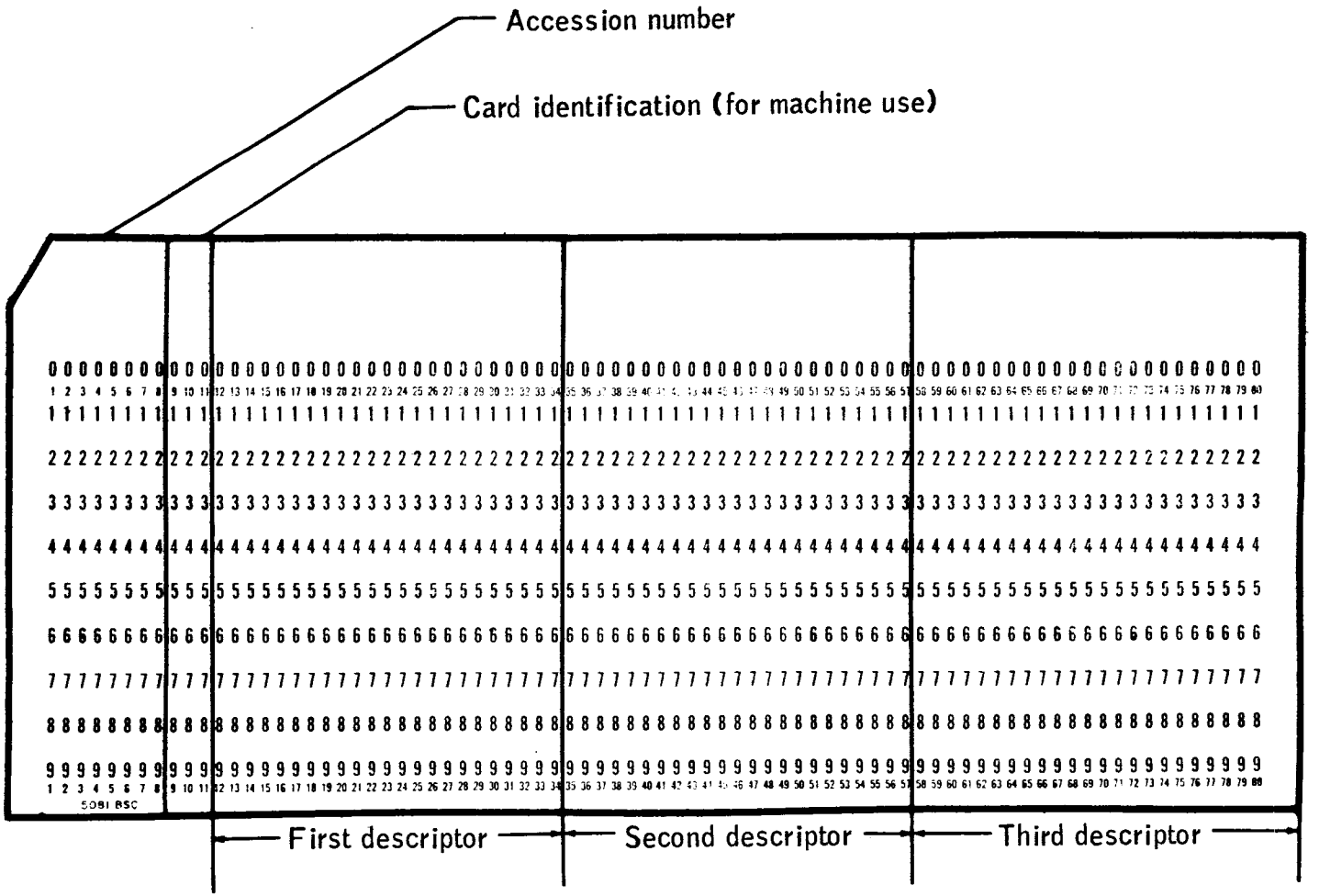


Figure 8.- Data fields on punched card corresponding to format of document processing sheet, page 2.

(1) Subject. (What was studied, investigated, tested, compiled, researched?)

(2) How was the subject treated (analysis, tests, design, production, computations, theory, specifications, operations, processes)?

(3) What are the physical factors (mechanical properties, physical properties, chemical effects, biological factors)?

(4) What equipment or method was used to support the research or investigation (spectrum analyzers, oscilloscopes, Charpy v-notch test equipment)?

(5) Where or under what environment was the research accomplished (upper atmosphere, arctic, subsurface, location if geographic or foreign)?

(6) Additional qualifying information (open-ended terms). (Project names, military symbols, trade names, Mark/Mod numbers, AN/numbers, et cetera.)

Figure 9.- Defense Documentation Center indexing checklist.

Role (1)	What was the input, raw material, reactant, base metal, uncombined component, input assembly, data input, material being acted upon, in which there was a characteristic or property change?
Role (2)	What was produced, built, resultant, manufactured, mixed, formed, refined, made, assembled, created?
Role (3)	What was undesirable, waste, scrap, rejects, impurity, pollutant, adulterant, poison?
Role (4)	What is the application—usage as, in, on, for, with?
Role (5)	What was the environment, medium, atmosphere, solvent, carrier, support, vehicle, et cetera?
Role (6)	What was the cause, independent variable, influencing factor, controlled variable?
Role (7)	What was the effect, dependent variable, influenced factor?
Role (8)	What is considered, discussed, reported, described?
Role (9)	What was passive, not changed in the process, possessed of, located in, on?
Role (10)	What was the method, means, device, employed, utilized?

Figure 10.- Engineers Joint Council indexing checklist.

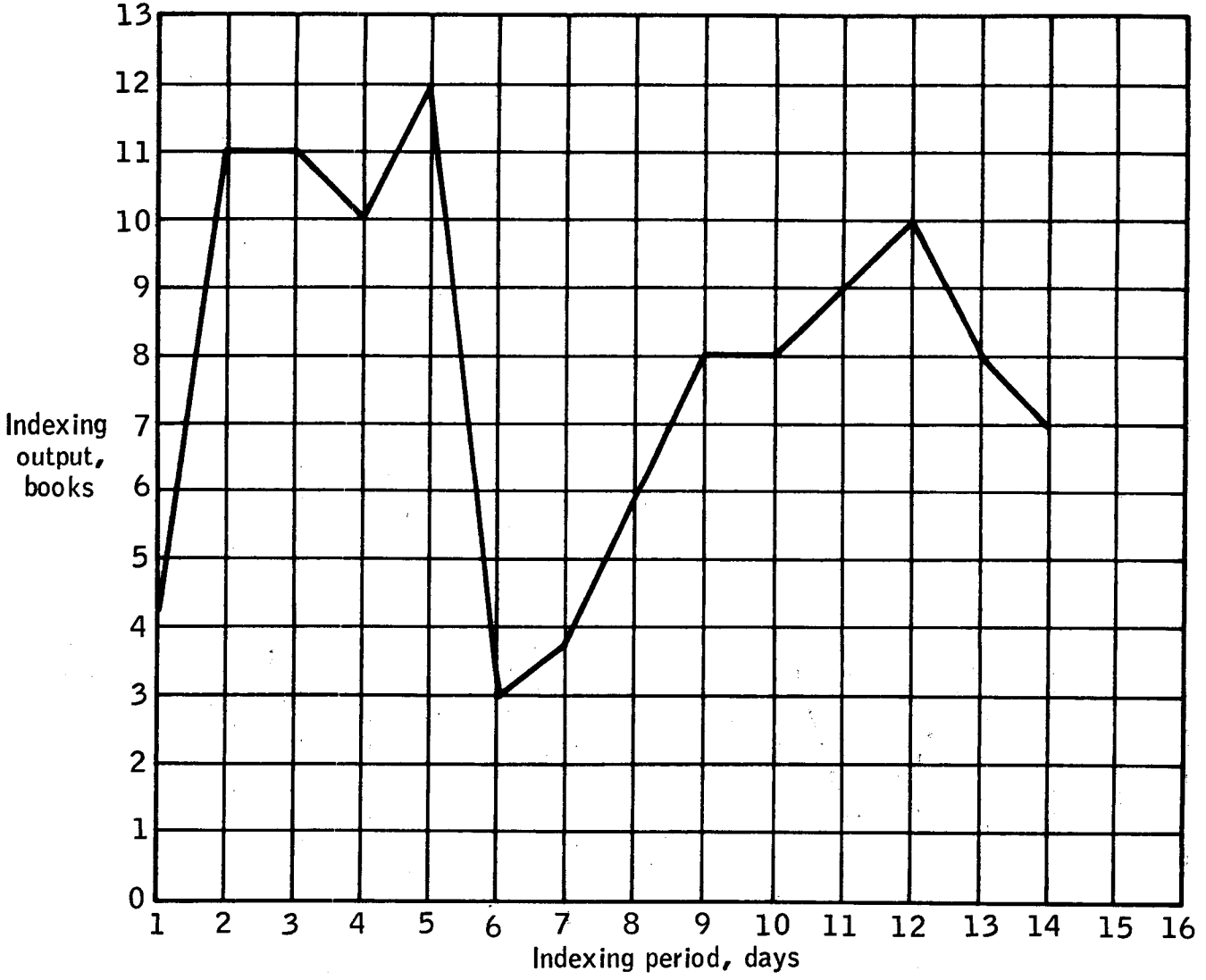


Figure 11.- Indexing output per indexing period.

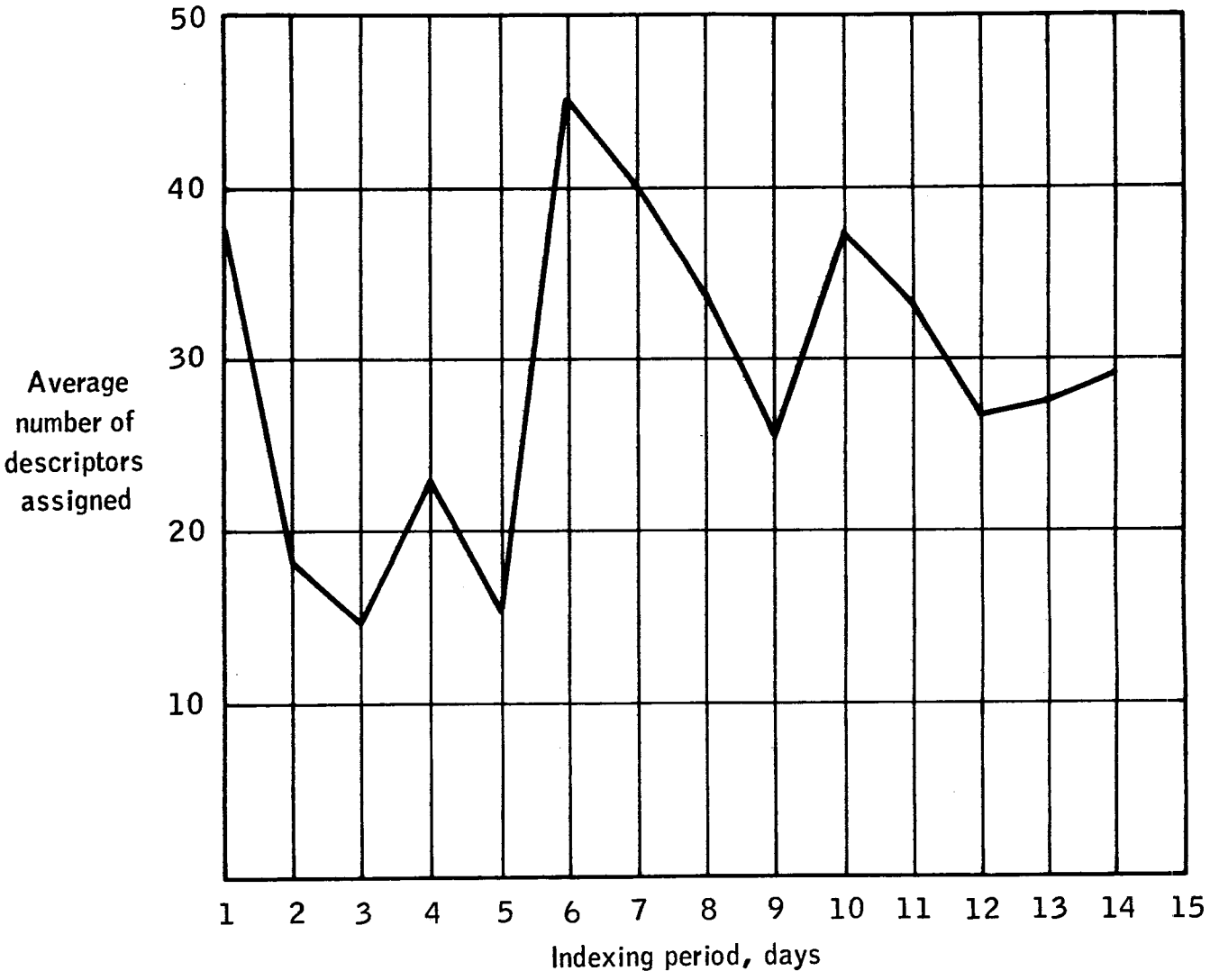


Figure 12.- Average number of descriptors assigned per indexing period.

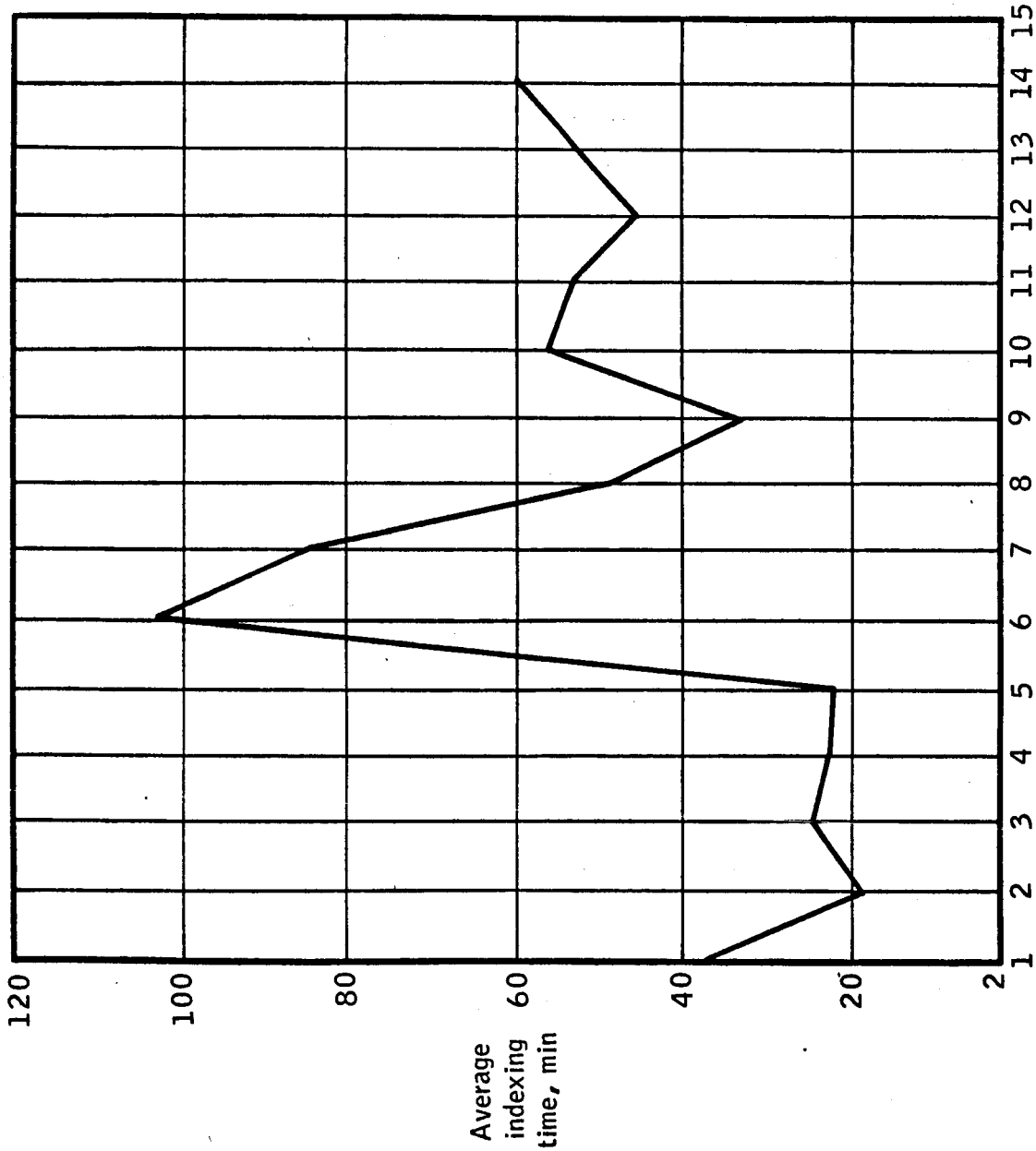


Figure 13. Average indexing time per indexing period.

Title: _____ Analyst: _____ Date _____ Page _____ of _____

Problem No. 10 Bibliography No. _____

Limit Code	Ref **	Wt. *	Limit
*1			TEST SEARCH 10 TRIAL 1
*2			RELATIØN ØF AFFINE CØNNECTIØN TØ FUNDAMENTAL TENSØR IN
40	A		UNIFIED FIELD THEØRY
40	B		AFFINE CØNNECTIØN
40	C		FUNDAMENTAL TENSØR
50			A+B+C$

#	No. of Acc.

Legend
Code Limit

00 Output Opt
01 Acc Rg (Pos
02 Acc Rg (Neg
03 Acc Series (A,N,X)
04 Security (1-6)
05 Subj Catego
06 Document Ty (00-09)
08 Corp Source (Term No.)
09 Contract No (Root)
10 Report No. (Root)
11 Personal Au (Root)
15 Sort Opt
40 Terms
49 Weight
50-59 Logical E
* Comment Card

LOGICAL DIAGRAM

KEYPUNCH INSTR.

(= %---0-4-8 Pu
) = ¤--12-4-8 Pu
+ = &--12 Pu

Note: * Weight (col. 11-12) is usable only for terms.
** Ref. (col. 9-10) is usable only for terms.
‡ Write "P" in col. 61 for published terms only.

NASA LINEAR FILE SEARCH WORKSHEET Facility Form 606/Rev. 12/

Figure 14.- NASA linear file search worksheet.

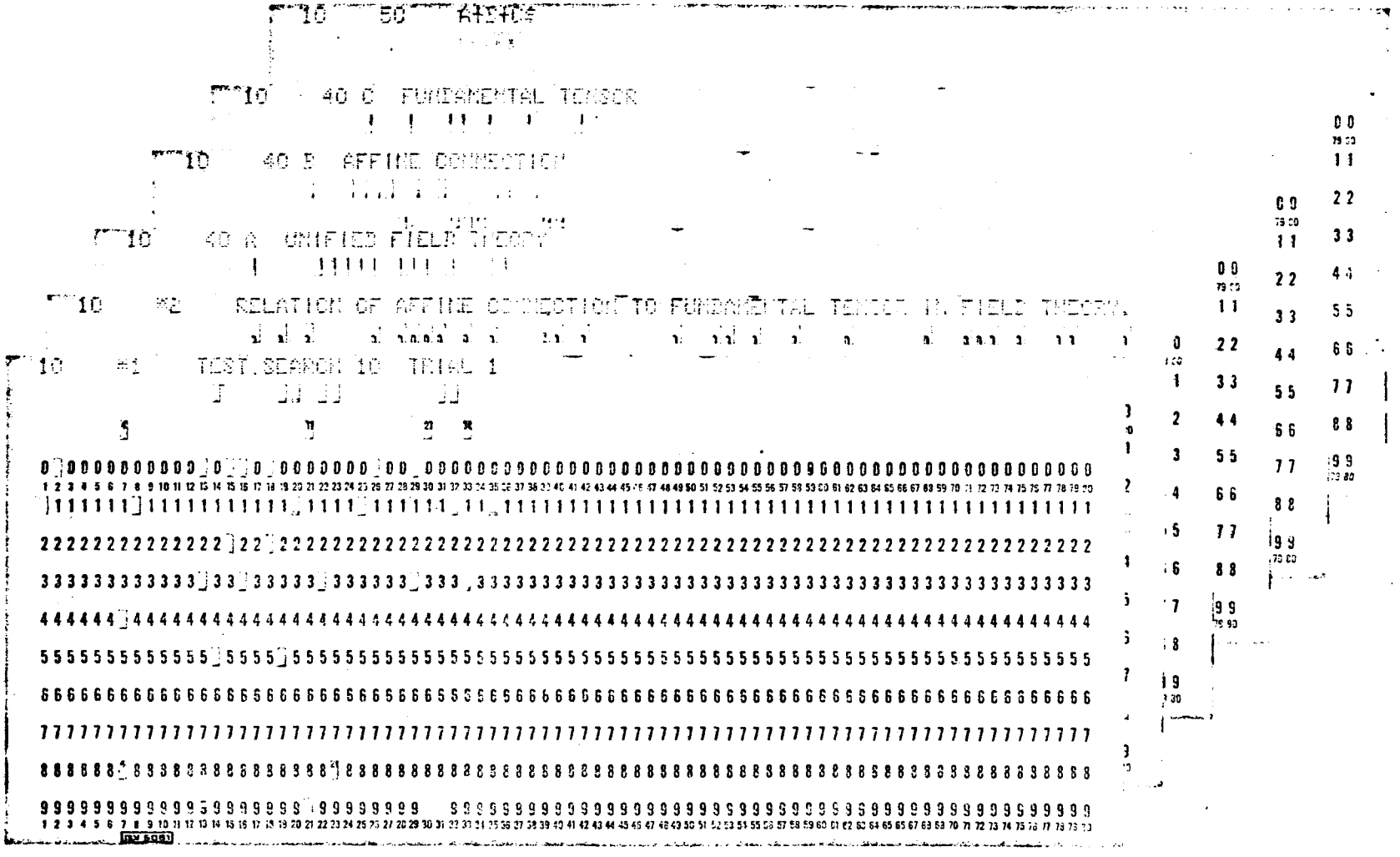


Figure 15.- Punched cards generated for retrieval searches.